DEPARTMENT OF THE INTERIOR
JOHN BARTON PAYNE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 466

GROUND WATER IN THE SOUTHINGTON-GRANBY AREA, CONNECTICUT

BY

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Prepared in cooperation with the
CONNECTICUT GEOLOGICAL AND NATURAL HISTORY SURVEY
Herbert E. Gregory, Superintendent

WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

CONTENTS.

ILLUSTRATIONS.

GROUND WATER IN THE SOUTHINGTON-GRANBY AREA, CONNECTICUT.

By Harold S. Palmer.

INTRODUCTION.

THE PROBLEM.

The census of 1910 reported the population of Connecticut as 1,114,756. The area of the State is 5,004 square miles. The average density of population is therefore about 220 per square mile, but the distribution of population is very uneven. More than 53 per cent of the inhabitants are gathered into 19 cities, each containing over 10,000. The cities are rapidly increasing in population, but parts of the State—about 24 per cent of the towns—are more sparsely settled to-day than in 1860. In a broad sense, the people of Connecticut are engaged in two occupations—manufacturing and mixed agriculture. Manufacturing is increasing at a rapid rate; agriculture at a slower rate, but with a distinct tendency toward specialization. There is in addition a tendency to utilize the scenery of the State—a tendency resulting in the development of country estates and shore homes.

As the stage of culture in a region rises it is necessary progressively to improve and increase the water supplies. Wild tribes are satisfied with the waters of springs and streams. Pastoral peoples need somewhat more water. Agricultural regions must have water at those points where it may be conveniently used; wells are made, springs are improved, and surface waters diverted to provide water at the points of utilization. In some arid regions extensive projects are constructed to supply irrigation water, as well as to supply water for domestic purposes and for watering stock. Industrial and mercantile communities, inasmuch as they are characterized by concentration of population in cities, demand a great deal of water, not only for human consumption but also for innumerable technical purposes.

With an annual precipitation of 45 inches, Connecticut has in the aggregate large supplies of both surface and ground water, but the precipitation is sometimes deficient through periods of several weeks or months. Consequently farmers must endure periods of drought,

manufacturers must provide against fluctuating water power, and the inhabitants of congested districts must arrange for adequate public supplies. With increase in population and diversification of interests conflicts between water-power users and domestic consumers, as well as between towns, for the right to make use of a particular stream or area have already arisen. Demands are also being made by prospective users of the waters for irrigation and drainage. The question of quality of water also takes on new meaning with the effort to improve the healthfulness of the State and to reclaim the waters now polluted by factory waste and sewage. The necessity for obtaining small but unfailing supplies of potable water for the farm and for the village home furnishes an additional problem, for the condition of many private supplies in Connecticut is deplorable.

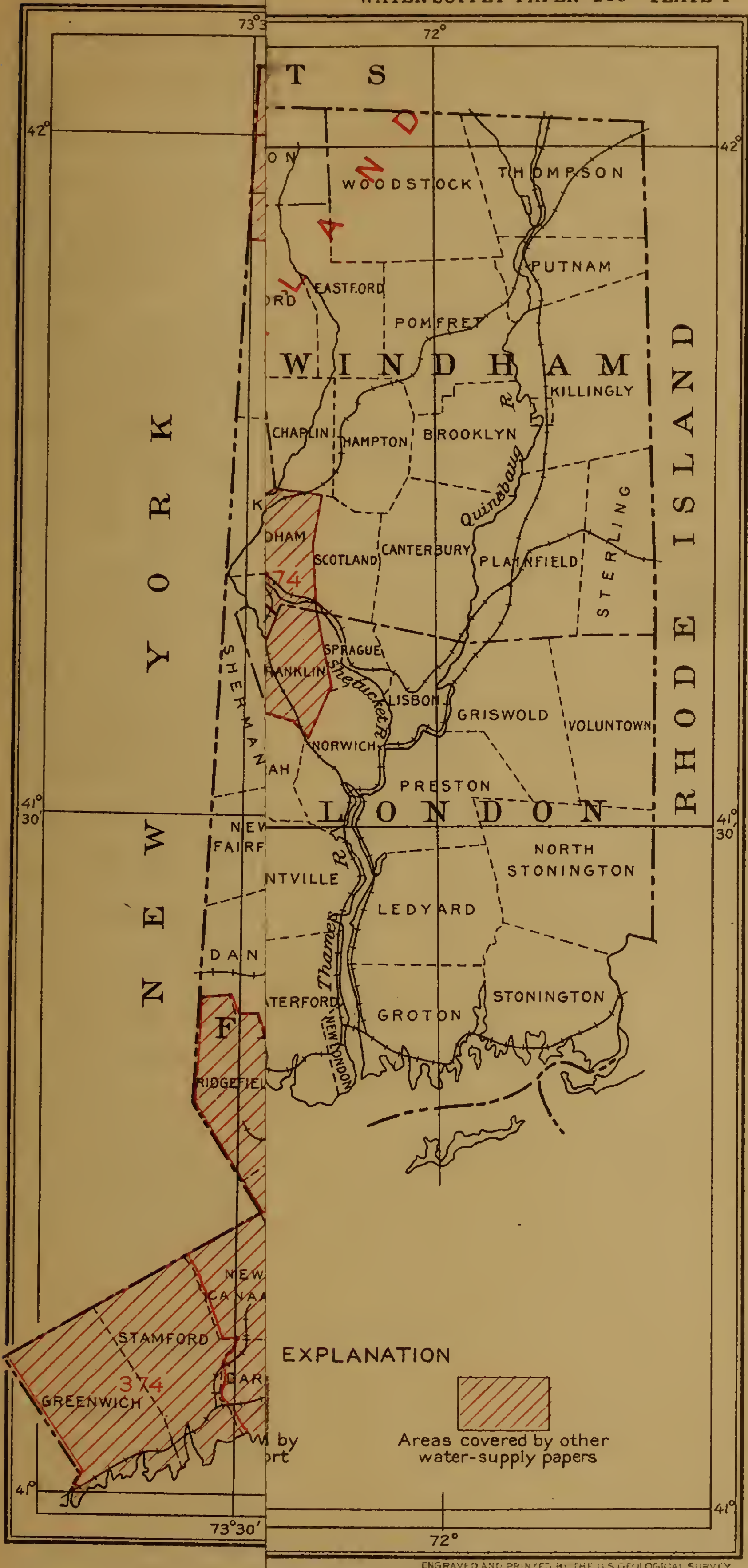
To meet the present situation and to provide for the future, State-wide regulations should be adopted. Obviously the first step in the solution of the Connecticut water problem is to make a comprehensive study of both surface and ground waters to obtain answers to the following questions: How much water is stored in the gravels and sands and bedrock of the State? How much does the amount fluctuate with the seasons? What is the quality of the water? How may it best be recovered in large amounts? In small amounts? What is the expense of procuring it? How much water may the streams of the State be relied upon to furnish? How much is the stream water polluted? How may the pollution be remedied? To what use should each stream be devoted? What is the equitable distribution of ground and surface waters among the conflicting claimants—industries and communities?

HISTORY OF THE INVESTIGATION.

The study of the water resources of Connecticut was begun in 1903 by Herbert E. Gregory, under the auspices of the United States Geological Survey. A preliminary report was issued in 1904.[1] A discussion of the fundamental problems relating to the State as a whole, published in 1909,[2] meets in a broad way the requirements of the scientist and the engineer, but it is not designed to furnish a solution for local problems and is not sufficiently detailed to furnish data for use in a quantitative study of ultimate supply and its utilization. It was recognized that conditions in the State are so varied that each section of the State has its individual problem, and that in order to obtain data of direct practical value the conditions in each town and, where feasible, around each farm and each village should be investigated.

[1] Gregory, H. E., Notes on the wells, springs, and general water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 102, pp. 127-168, 1904.

[2] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, 1909.


N E W Y O R K
R H O D E I S L A N D
W I N D H A M
L O N D O N
WOODSTOCK
THOMPSON
PUTNAM
EASTFORD
POMFRET
KILLINGLY
CHAPLIN
HAMPTON
BROOKLYN
SCOTLAND
CANTERBURY
PLAINFIELD
STERLING
SPRAGUE
LISBON
GRISWOLD
VOLUNTOWN
NORWICH
PRESTON
NORTH STONINGTON
LEDYARD
STONINGTON
GROTON
NEW LONDON
Quinebaug R.
Shetucket R.
Thames R.
STAMFORD
GREENWICH
RIDGEFIEL
374
72°
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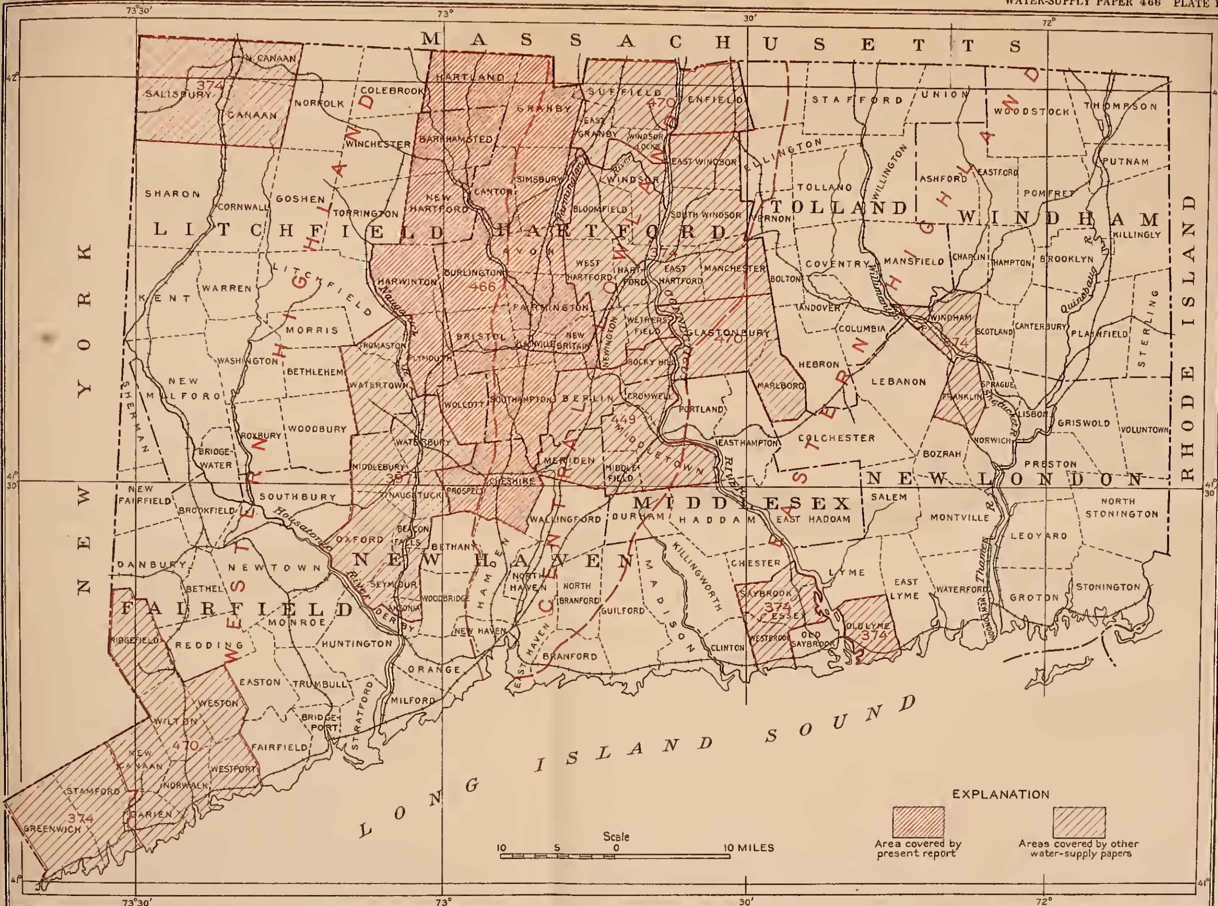
EXPLANATION
Areas covered by other water-supply papers
ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

THE PRESENT



MAP OF CONNECTICUT SHOWING MAIN PHYSIOGRAPHIC DIVISIONS AND AREAS TREATED IN THE PRESENT AND OTHER DETAILED WATER-SUPPLY PAPERS OF THE U. S. GEOLOGICAL SURVEY

Realizing the importance of such studies to Connecticut, the State joined forces with the Federal Government in order to carry on this work. In 1911 a cooperative agreement was entered into by the United States Geological Survey and the Connecticut Geological and Natural History Survey for the purpose of obtaining information concerning the quantity and quality of waters available for municipal and private uses. The investigation was placed in charge of Mr. Gregory and was to be conducted through a period of two or more years, the cost to be shared equally by the parties to the agreement.

The work has consisted in gathering information concerning municipal water supplies; measuring the dug wells used in rural districts and obtaining other data in regard to them; obtaining data concerning drilled wells, driven wells, and springs; collecting and analyzing samples of water from wells, springs, and brooks; studying the character and relations of bedrock and of surficial deposits with reference to their influence upon the ground-water supply.

A. J. Ellis spent the field seasons of 1911, 1912, and 1913 on this work under the cooperative agreement. A report has been published on 13 towns around Waterbury,[3] and another on 10 towns around Hartford, 4 around Saybrook, 3 around Salisbury, and on Stamford, Greenwich, Windham, and Franklin.[4]

Parts of the summer and fall of 1914 and 1915 were spent by the writer in field work on the towns discussed in this report. Six weeks in April and May, 1915, were spent by G. A. Waring in the towns in the vicinity of Meriden and Middletown, and the results of his work have been published.[4a] A report on four towns in the Pomperaug Valley is in preparation. The index map (Pl. I) shows the areas covered by the several reports.

The area with which the present report is concerned comprises parts of two of the physiographic provinces of Connecticut. Avon, Cheshire, Farmington, New Britain, Plainville, Simsbury, and Southington are in the central lowland. Barkhamsted, Burlington, Canton, Hartland, Harwinton, New Hartford, Plymouth, Prospect, and Wolcott are in the western highland. Bristol and Granby are about evenly divided between the lowland and the highland.

RELIABILITY OF DATA.

The principal well data are given in tables appended to the reports on the several towns. The depth of the dug wells and the depth of the water in them were determined by measurement. The information presented as to depth to rock, the consumption of water, and the

[3] Ellis, A. J., Ground water in the Waterbury area, Conn.: U. S. Geol. Survey Water-Supply Paper 397, 1916.

[4] Ellis, A. J., Ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, Conn.: U. S. Geol. Survey Water-Supply Paper 374, 1916.

[4a] Waring, G. A., Ground water in the Meriden area, Conn.: U. S. Geol. Survey Water-Supply Paper 449, 1920.

reliability of the supply, is in general based on statements made by local residents. The elevations of the wells and springs were determined from the topographic maps of the United States Geological Survey. The estimate of the yield of drilled wells are based on tests made by the drillers when the wells were completed. Information concerning the yield of a few improved springs was obtained by measurements of the overflow; the yield of others was computed from measurements of the velocity and cross section of the streams issuing from them, for still others the figures given represent the yield as estimated by the owners. The yield of a number of dug wells from which water is piped under gravity was determined by timing the filling of a vessel of known capacity. Intensive studies were made of the yield of two wells—one dug in till and the other blasted into sandstone.

The data relating to drilled wells were obtained from the owners or from drillers. Several owners of springs and wells have made observations of various sorts. The information obtained in this way or generously supplied by superintendents of waterworks and by municipal engineers is acknowledged with thanks.

Free use has been made of the technical literature dealing with water supplies, and credit is given for specific facts taken from these sources, but the report contains also material gathered from the reports of previous investigations, some of which can not well be attributed to any one author.

GEOGRAPHY.

TOPOGRAPHY.

GENERAL FEATURES.

The Southington-Granby area lies in part in the central lowland physiographic province of Connecticut, and in part in the western highland province. These relations are shown in the index map (Pl. I). The western boundary of the area follows roughly the divide between Naugatuck River and the Quinnipiac and Mill River valley in its southern part; it follows Naugatuck River for 8 miles in the middle; but the northern part is not related to the topography. The eastern boundary in general follows the crest of the trap ridges of Talcott Mountain and Meriden West Peak. The total area including water bodies, obtained by adding the town areas determined from the maps by use of a planimeter, is a little over 500 square miles. The greatest length from north to south is 40 miles and the greatest width is 17 miles.

There are in a sense three major topographic elements in the Southington-Granby area. Along the eastern margin is a ridge 200

to 700 feet high formed by the upturned edges of sheets of trap rock. West of the trap ridges is a valley from 3 to 5 miles wide, cut in relatively soft sandstone and shale. Quinnipiac and Mill rivers drain the southern part of this valley, and Farmington River, Pequabuck River, and Salmon Brook the northern part. The valley is bounded on the west by a steep slope, 200 to 800 feet high, that forms the front of the western highland plateau, the third element.

THE HIGHLAND.

The highest point in the Southington-Granby area is Pine Mountain, in the northeast corner of Barkhamsted, 1,420 feet above sea level. Inspection of the map (Pl. II) will show that the hills to the south are lower than those to the north, and that the decrease in elevation is uniform. The highest point in Canton is Ratlum Mountain, 1,200 feet; in Burlington, Johnnycake Mountain, 1,160 feet, in Wolcott, Spindle Hill, 1,020 feet; and in Prospect, a ridge south of the center, 880 feet above sea level. The lowest point in the whole area is the point where a tributary of Mattabesset River crosses the south boundary of New Britain, only 55 feet above sea level. The total range in elevation is therefore about 1,365 feet.

The western highland is traversed by three major valleys, of which one, the Naugatuck-Still River valley, roughly follows part of the western border of the Southington-Granby area. It is cut several hundred feet below the plateau and constitutes one of the few feasible lines of communication from north to south in the western highland. Farmington River occupies one of these valleys in its upper course.

THE LOWLAND.

The Farmington-Quinnipiac Valley is part of the central lowland physiographic province of Connecticut, and most of it is included in the Southington-Granby area. Gregory [5] says of this valley:

> The Farmington-Quinnipiac Valley extends from New Haven northward across the State and is bounded on the west by the steep edge of the western highland and on the east by the broken wall of the central [trap] ridge. It is occupied by three rivers—the Farmington, Quinnipiac, and Mill [New Haven]—all of which, in common with their tributaries, flow almost entirely on glacial drift. From the floor of Farmington-Quinnipiac Valley rise a number of trap hills which break the continuity of the plain. Among the more prominent of these are the Barndoor Hills in Granby, 600 to 700 feet [above sea level]. The level, drift-filled floor of this valley lowland, together with the slight difference in elevation between New Haven and the Congamuck ponds, made the valley an attractive route for a canal, which was built in 1829 and was later succeeded by the Northampton Railroad.

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[5] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 17, 1909.

The divide between Farmington and Quinnipiac rivers, from which they flow respectively northward and southward, is only 190 feet above sea level.

CLIMATE.

The outstanding features of the climate of Connecticut are the fairly high humidity, the uniformity of precipitation throughout the year, and the relatively great length of the winters.[6] The winter occupies five or six months, and spring, summer, and autumn are crowded into the remainder of the year. Spring is brief, but summer is longer and well defined and, with the exception of short hot waves,

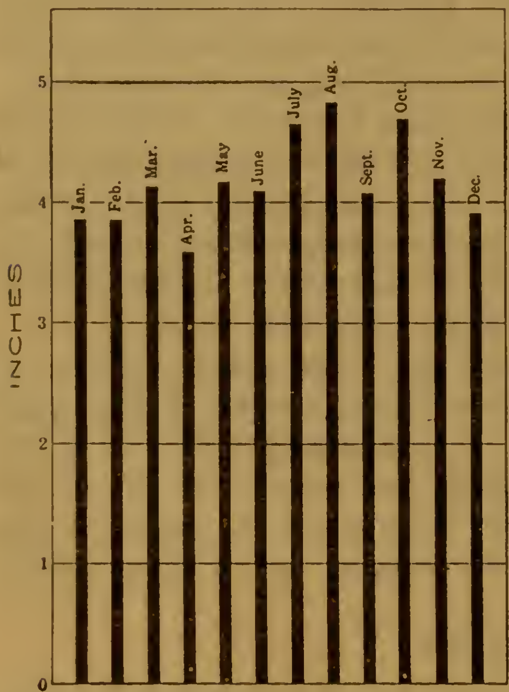

FIGURE 1.—Mean monthly precipitation at Canton.

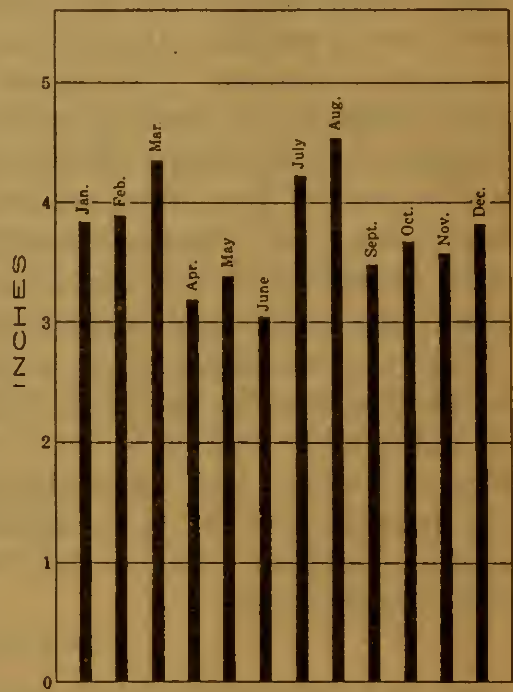

FIGURE 2.—Mean monthly precipitation at Southington.

is very pleasant. The fall is delightful, as it has many warm days with cool nights. The spring comes so quickly that the snow melts very rapidly and sometimes makes strong freshets. The winds are prevailingly westerly, but in May and June there is a good deal of east wind.

The Weather Bureau maintains no stations within the Southington-Granby area, but the data given in the report cited for Cream Hill, in Cornwall, are probably representative of the conditions in the northwestern part of the area, and the data for Hartford of those in the southeastern part.

[6] Summaries of climatological data of the United States, by sections: U. S. Weather Bureau Bull. W, section 105, 1912.

Climatic data for Cream Hill and Hartford, Conn.

	Cream Hill.	Hartford.
Temperature (°F.):		
Mean annual	46.0	48.5
Maximum	96	98
Minimum	−15	−20
Precipitation (inches):		
Mean annual	48.06	44.30
Annual snowfall	75.8	47.2
Frosts:		
Average date:		
First killing	Sept. 26	Oct. 10
Last killing	May 1	Apr. 28
Earliest recorded	Sept. 20	Sept. 19
Latest recorded	May 12	May 12

There is in general abundant precipitation in Connecticut, though sometimes more or less protracted summer droughts may occur.

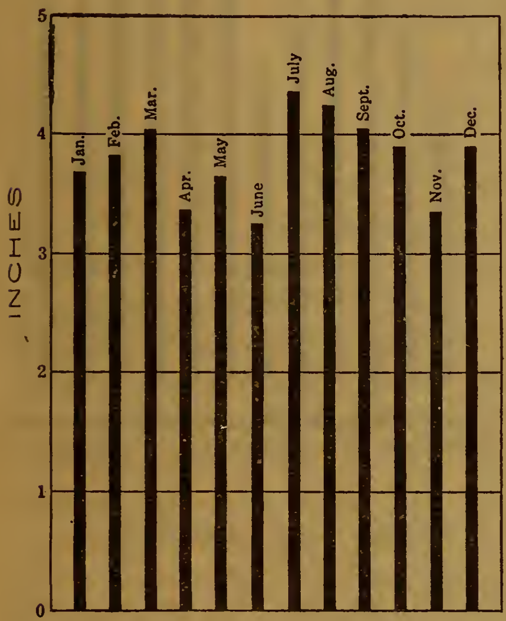

FIGURE 3.—Mean monthly precipitation at West Simsbury.

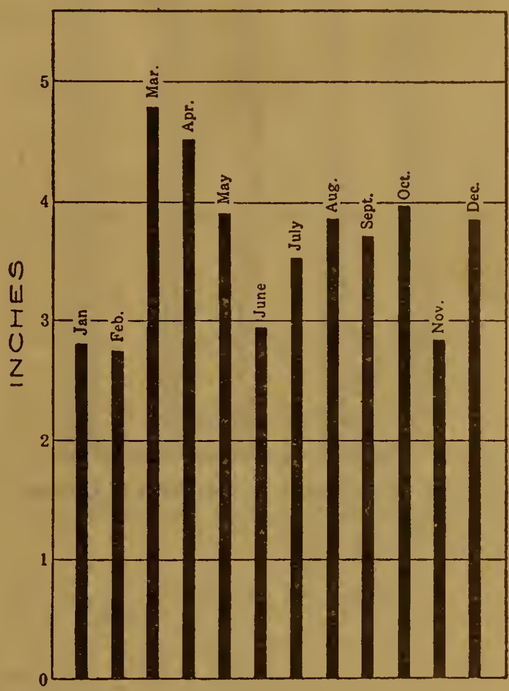

FIGURE 4.—Mean monthly precipitation at Shuttle Meadow, New Britain.

The following tables are summaries of longer tables and show the average, maximum, and minimum monthly precipitation at five points in the Southington-Granby area. The tables for Canton, Southington, and West Simsbury represent longer periods than the other tables and are therefore probably more accurate. Figures 1, 2, 3, 4, 5, and 6 show graphically the precipitation and its distribution through the seasons.

Summary of precipitation, in inches, at Canton, Conn., 1862–1915.[a]

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Maximum	7.10	9.11	9.57	12.30	18.00	12.36	16.96	16.45	11.25	14.70	9.28	9.07	75.16
Minimum	.81	.49	.19	.68	.51	.20	1.36	.73	.29	.62	.70	.64	38.90
Average	3.85	3.84	4.12	3.58	4.15	4.09	4.64	4.82	4.06	4.68	4.18	3.90	49.93

[a] Data collected by G. J. Case. Figures for 1862–1913 from Sixtieth Annual Report of the Board of Water Commissioners of Hartford. Figures for 1914 and 1915 furnished by Mr. Case.

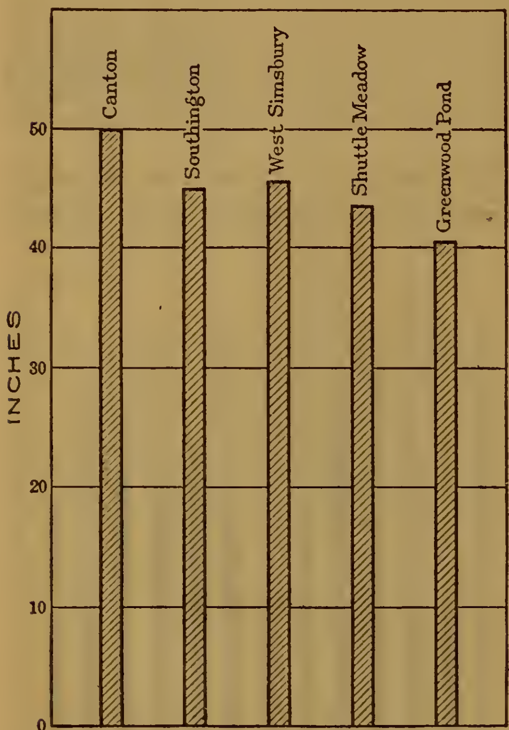

FIGURE 5.—Mean annual precipitation at Canton, Southington, West Simsbury, Shuttle Meadow, and Greenwood Pond.

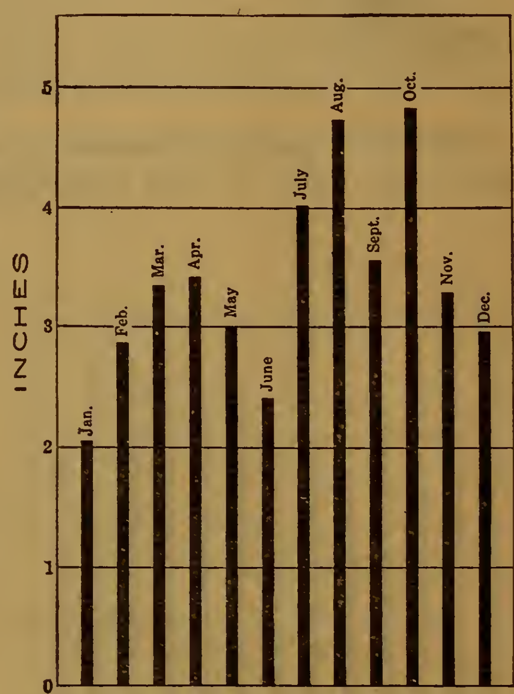

FIGURE 6.—Mean monthly precipitation at Greenwood Pond, New Hartford and Barkhamsted.

Summary of precipitation, in inches, at Southington, Conn., 1870-1913.[a]

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Maximum	10.81	7.70	8.45	9.65	7.00	12.10	19.90	9.55	11.90	10.30	7.68	9.80	63.54
Minimum	1.47	.90	.87	.85	.03	.45	1.15	.40	.38	.55	.65	1.05	30.02
Average	3.83	3.90	4.34	3.20	3.40	3.06	4.23	4.54	3.50	3.66	3.57	3.82	45.05

[a] Goodnough, X. H., Rainfall in New England: New England Waterworks Assoc. Jour., Sept., 1915.

Summary of precipitation, in inches, at West Simsbury, Conn., 1890-1912.[a]

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Maximum	6.70	9.06	6.76	11.10	7.15	9.79	16.21	7.38	9.83	6.49	6.48	8.06	59.53
Minimum	1.41	.52	.64	.66	.73	.51	1.17	.75	1.17	.90	.61	1.28	35.71
Average	3.66	3 83	4.04	3.37	3.65	3.24	4.37	4.24	4.03	3.90	3.35	3.89	45.57

[a] Goodnough, X. H., op. cit.

Summary of precipitation, in inches, at Shuttle Meadow, New Britain, Conn., 1899-1902, 1904-1906, and 1908-1913.[a]

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Maximum	4.89	8.03	7.06	9.36	7.72	6.05	7.24	6.41	7.48	9.17	5.63	10.03	......
Minimum	.46	.00	.58	1.61	.02	.22	1.45	.50	.59	.20	.26	1.35	......
Average	2.80	2.72	4.79	4.53	3.92	2.94	3.52	3.85	3.70	3.97	2.83	3.85	43.42

[a] Compiled from annual reports of the Board of Water Commissioners of New Britain.

Summary of precipitation, in inches, at Greenwood Pond, New Hartford, Conn., 1910-1915.[a]

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Number of years in record	3	4	4	5	5	5	5	6	6	6	5	4	......
Maximum	2.54	4.44	6.16	4.67	4.73	3.26	7.01	8.20	5.98	8.94	4.34	4.12	......
Minimum	1.12	1.68	1.31	2.27	1.76	.53	2.30	2.42	.08	.84	1.64	2.42	......
Average	2.06	2.87	3.34	3.42	2.99	2.40	4.01	4.72	3.56	4.83	3.29	2.96	40.45

[a] Discontinuous record furnished by Mr. Aaron Watson.

SURFACE WATERS.

The Southington-Granby area comprises parts of five drainage basins. About half of Cheshire and a little of Prospect are drained by Mill River, which enters Long Island Sound at New Haven. Parts of Prospect, Wolcott, Plymouth, Harwinton, and New Hartford are drained by small streams tributary to Naugatuck River. New Britain is in large part drained to the Connecticut. A little of western New Britain is drained by Quinnipiac River, which flows through a gap (Cooks Gap) in the long lava ridge and then turns south to enter Long Island Sound at New Haven. Many small streams in Bristol, Wolcott, and Cheshire and all of those in Southington are tributary to the Quinnipiac. Farmington River flows through this area and joins the Connecticut above Hartford, and the streams draining the rest of the area are tributary to it. The divide between the Farmington and Naugatuck basins is very sinuous, but for most of its length it is much nearer to Naugatuck River than to Farmington River.

As in all other glaciated regions lakes and ponds are abundant in the Southington-Granby area. Some of the swamps in the area are former water bodies that have been filled with sediment.

When water falls as rain or snow a part evaporates, another part enters the ground, and a third part flows off directly into streams. Some of the ground water is lost by evaporation and by transpiration from trees and other plants. The ratio of run-off to rainfall is highly variable, as it depends on many factors, such as the rate of precipitation, its distribution throughout the year, the character and thickness of the soil, the steepness of slopes, the abundance of vegetable covering, the amount of frost in the soil, and the character and structure of the rocks.

The following tables give some idea of the run-off in two basins in Connecticut:

Monthly run-off of Pomperaug River at Bennetts Bridge and precipitation in Pomperaug drainage basin.[a]

[Area of basin 89.3 square miles.]

Month.	Precipitation (inches).	Run-off. Depth in inches on drainage basin.	Run-off. Per cent of precipitation.
1913.			
August	3.19	0.25	6.8
September	3.53	.35	9.9
October	9.66	2.57	26.6
November	3.05	2.73	89.5
December	2.72	2.24	81.7
1914.			
January	2.15	1.33	61.8
February	2.14	.58	27.1
March	5.63	4.32	76.6
April	4.35	2.94	67.5
May	3.19	2.35	73.6
June	2.83	.63	22.3
July	5.91	.70	11.8
August	3.66	.45	12.3
September	.36	.20	55.6
October	3.31	....	....
November	3.37	.50	14.8
December	2.82	....	....
1915.			
January	6.21	....	....
February	5.70	....	....
March	.15	1.61	1,070
April	1.59	1.60	100.6
May	3.37	1.21	35.9
June	2.01	.45	22.4
July	6.31	.78	12.4
August	8.09	1.79	22.1
September	2.94	.92	31.3
October, 1913, to September, 1914	45.65	38.95	85.4

[a] Data obtained from unpublished report by A. J. Ellis, U. S. Geol. Survey.

Precipitation and run-off in Housatonic River basin above Gaylordsville, Conn., 1901–1903, 1906–1909.[a]

[Area of basin 1,020 square miles.]

Year.	Precipitation (inches).	Run-off. Depth in inches on drainage basin.	Run-off. Per cent of precipitation.
1901	56.94	29.65	52.1
1902	61.43	38.62	62.9
1903	56.85	39.65	69.8
1906	46.31	22.17	47.9
1907	55.80	29.47	52.9
1908	40.26	19.67	48.8
1909	44.75	19.85	44.4

[a] Compiled from Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 29, 1909, and from Surface-water supply of the United States, 1907–8 and 1909: U. S. Geol. Survey Water-Supply Papers 241 and 261.

The Tenth Census report on water power gives figures taken from various sources concerning the ratio of run-off to precipitation in a number of drainage basins. The data for four of these basins in the northeastern United States are summarized in the following table:

Precipitation and run-off in northeastern United States.

River basin.	Area of basin (square miles).	Length of record (years).	Annual precipitation (inches).	Run-off (per cent of precipitation).		
				Mean.	Maximum.	Minimum.
Connecticut above Hartford	10,234	7	42.7	62.8	72.2	51.8
Sudbury	78	5	46.1	47.6	57.9	32.7
West Branch of Croton	20.37	4+	50	62.9		
Croton	339	13	49.79	56.5		

The difference between the run-off of the basin of West Branch of Croton River and that of the whole Croton drainage basin is due to the fact that the former is a steep, rocky, thin-soiled, and relatively untilled region, whereas the latter is flatter and more cultivated and therefore absorbs more of the rain.

WOODLANDS.

About 35 per cent of the area of the lowland towns of the Southington-Granby area is wooded, but in the highland about 65 per cent is wooded. The greater facility of transportation in the lowland, together with the nearness of markets and the more readily tillable nature of the soils, has stimulated the clearing away of the forests. At present the forests of the lowland are for the most part represented by small woodlots. On the plains there are some extensive stands of white and yellow pine with small admixtures of deciduous trees, and the trap ridges are in large part covered with deciduous forests. In the highland there are relatively few evergreen trees but numerous chestnuts, oaks, hickories, elms, maples, beeches, birches, and other hardwoods. A great amount of cordwood and native lumber is produced. The manner of cutting wood has heretofore been very wasteful, and few attempts at reforestation have been made. Cut-over lands have been allowed to grow up with sprout and staddle, and the woodlands have in consequence deteriorated steadily. In the last decade, however, there has been some systematic planting of trees. and the cutting has been a little less ruthless. The wood crop would be a very profitable one were the industry prosecuted in a proper manner, as the soil is in general very good, and if given a chance will mature most kinds of trees sufficiently for the market in 20 to 30 years.

POPULATION AND INDUSTRIES.

The Southington-Granby area comprises 18 towns which belong in three counties. The towns are Avon, Bristol, Burlington, Canton, Farmington, Granby, Hartland, New Britain, Plainville, Simsbury, and Southington, in Hartford County; Barkhamsted, Harwinton, New Hartford, and Plymouth, in Litchfield County; and Cheshire, Prospect, and Wolcott, in New Haven County.

FIGURE 7.—Map showing density of population in the Southington-Granby area in 1910.

The distribution of population and the occupation of the people in this area depend in large part on the physiographic features of the area. The bulk of the population, as indicated on the population-density map (fig. 7), is concentrated in the six adjacent lowland towns—New Britain, Bristol, Southington, Plymouth, Farmington, and Plainville. The total population of these towns was 75,315 in 1910, or 81 per cent of the population of the whole area. The area is 139 square miles, or 28 per cent of the total area. Thus 81 per cent of the people dwell in only 28 per cent of the area. The density of the population in these towns is about 540 inhabitants to the square

FIGURE 8.—Map showing density of population in the Southington-Granby area in 1850.

mile. The population is next greatest in those highland towns which are cut by valleys that provide not only power sites but also avenues of communication. The six typical highland towns of the area—Barkhamsted, Hartland, Harwinton, Burlington, Prospect, and Wolcott—are sparsely populated. Although they comprise 171 square miles, or 32 per cent of the total area, they have only 5,270 inhabitants, or 6 per cent of the total population. The population density is 31 to the square mile.

The heavier shading on the map brings out the concentration of the population along the lowland and particularly in the region of the east-west line of the Highland division of the New York, New Haven & Hartford Railroad. A comparison of this map with the map showing the population density in 1850 (fig. 8) will show the extent and character of the movements of population in the 60 years between 1850 and 1910. In 1850 there were no towns with less than 25 inhabitants to the square mile; in 1910 there were two. In 1850 there were only two towns with over 100 to the square mile; in 1910 there were six. In 1850 only one town had as many as 223 inhabitants to the square mile; in 1910 there were four.

The following table gives statistics concerning the eighteen towns considered in this report:

Statistics of towns in Southington-Granby area.

Town.	Area (square miles).[a]	Population.[b]			Inhabitants per square mile, 1910.
		1900	1910	Gain (per cent).	
Avon	22.7	1,302	1,333	3	59
Barkhamsted	38.9	864	865	0	22
Bristol	26.8	9,643	13,502	40	504
Burlington	31.1	1,218	1,319	8	42
Canton	29.5	2,768	2,732	2	93
Cheshire	31.9	1,989	1,988	0	62
Farmington	28.7	3,331	3,478	3	121
Granby	41.3	1,299	1,383	6	33
Hartland	33.7	592	544	c 8	16
Harwinton	30.8	1,213	1,440	19	47
New Britain	13.6	28,202	43,916	56	3,230
New Hartford	37.4	3,424	2,144	c 37	57
Plainville	9.6	2,189	2,882	32	300
Plymouth	22.3	2,828	5,021	77	223
Prospect	15.0	562	539	c 4	36
Simsbury	30.6	2,094	2,537	21	83
Southington	38.2	5,890	6,516	11	170
Wolcott	21.1	581	563	c 3	27
	503.2	69,899	92,702	32.6	184

a Areas measured with planimeter on topographic sheets.
b Population figures from Connecticut Register and Manual, 1915.
c Loss.

The broad, rolling plains of the Farmington and Quinnipiac valleys early attracted settlers by reason of their easily tillable and fairly fertile soils. The valley gave a ready line of communication with the sea. At first there were only rough trails and bridle paths, but soon good roads were built over which much freight was hauled. In

the early part of the nineteenth century a canal was built through the valley from New Haven to Northampton. The canal was operated from 1827 to 1848,[7] when it was replaced by a railroad. During the period of canal transportation the villages in the steep valleys of the highland, especially those near the debouchures of streams on the lowland, where there were sites suitable for the development of water power, became of some importance. The towns which were more remote from the canal and in which power sites were few fell behind in many respects and even decreased in population. The construction of railroads accentuated the differences that were first developed by the canal. The Northampton Railroad, which follows the old canal, was put into operation in 1848. In 1849 the Highland division through New Britain, Plainville, Bristol, and Plymouth was built, and in 1850 the New Hartford branch of the Northampton road was opened. Then there was a lull in railroad building till 1871, when the Central New England Railway went through Simsbury, Canton, and New Hartford. The Meriden-Waterbury Railroad, which runs through Cheshire, was built a few years later.

There are now many factories in the Southington-Granby area and they afford subsistence to most of the population. Agriculture is a subordinate occupation. A few special crops of considerable value are raised—tobacco in Simsbury, Granby, and Avon; orchard fruits in Cheshire, Southington, and Farmington; and dairy products, garden truck, cordwood, and native lumber in most of the towns.

GEOLOGIC HISTORY.

Very little is known of the early geologic history of Connecticut, for the old rocks have suffered so many changes that the evidence given by them is almost impossible to interpret. It is certain that in pre-Cambrian and early Paleozoic time sediments were deposited. The first deposits were sand, mud, and clay, which became consolidated to form sandstone and shale, but later, in Ordovician time, some limestone was deposited. No fossils have been found in these rocks, but their age has been roughly determined by studying the relative positions of the formations and by tracing them into regions where more evidence is to be had.

From the end of the Ordovician period to the Triassic period no sediments were formed, or if any were formed they have since been completely removed. During this interval there were several great mountain-building disturbances, characterized by compression of the earth's crust in an east-west direction, and the intrusion of vast quantities of igneous rock. To the compression is due the change of the old shales and sandstones to the schists and gneisses of the highland.

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[7] Brandegee, A. L., and Smith, E. A., Farmington, Conn., pp. 132 et seq.

The igneous rocks, in large part, were also crushed and converted to gneisses.

During Triassic time the mountains were deeply eroded, and much of the débris was deposited in a troughlike valley in central Connecticut. The sediments are for the most part red shales, sandstones, and conglomerates, but there are some dark bituminous shales and green and gray limy shales. In some places in the red rocks footprints of reptiles, both large and small, and a few of their bones have been found. The footprints and bones indicate that the rocks are of Triassic age, as do also the remains of fishes found in places in the bituminous shales.

The deposition of the Triassic sediments was interrupted three times by the gentle eruption of basaltic lava, which spread out across the wide valley floor and which now forms the trap ridges between the Farmington and Connecticut valleys. Into the already buried sediments were also intruded other masses of basaltic lava that formed the sills, dikes, and laccoliths characteristic of the western edge of the central lowland.

Subsequently, presumably in the Jurassic period, the flat-lying sedimentary rocks and their intercalated trap sheets were broken into blocks by a series of faults that cut diagonally across the lowland in a northeasterly direction. Each block was rotated so that its southeast margin was depressed and its northwest margin elevated.

There is no sedimentary record of the interval from the Triassic period to the glacial epoch, but the erosion that took place in that interval has left its mark. During Cretaceous time the great block mountains formed by the Jurassic faulting were almost completely worn away. It is believed by Davis [8] and others that during part of the Cretaceous period the sea advanced over Connecticut as far as Hartford, and that the submerged area was covered with marine deposits. No such beds have survived to the present day, and the only evidence of them is indirect. Most of the streams in the region flow about due south, but parts of the more powerful ones—for example, the lower Connecticut—have southeasterly courses. It is possible that when the Cretaceous deposits were raised they were tilted toward the southeast, and the courses of the streams across these beds were similarly deflected. The more vigorous streams were perhaps able to impose their channels on the discordant rock surface below the Cretaceous beds, whereas the smaller streams were turned back to their old channels by elevations of the rock surface.

It was noted by Percival [9] that the highlands may be regarded "as extensive plateaus" which "present when viewed from an elevated

[8] Davis, W. M., The Triassic formation of Connecticut: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, p. 165, 1898.

[9] Percival, J. G., Report on the geology of Connecticut, p. 477, 1842.

point of their surface the appearance of a general level, with a rolling or undulating outline, over which the view often extends to a very great distance, interrupted only by isolated summits of ridges, usually of small extent." Rice [10] has described the phenomenon as follows: "If we should imagine a sheet of pasteboard resting upon the highest elevations of Litchfield County and sloping southeastward in an inclined plane, that imaginary sheet of pasteboard would rest on nearly all the summits of both the eastern and western highlands." The rocks of this plateau are the roots of the mountains that stood there in late Paleozoic and early Mesozoic time. They have been worn away and a more or less perfect plain made in their stead.

Barrell [11] has pointed out, however, that the hilltops approximate not an inclined plane but a stairlike succession of nearly horizontal planes, each a few hundred feet lower than the next one to the north.

Plate IV, *A*, is a reproduction of a photograph taken from the northeastern part of Harwinton looking toward the northwest. The rolling foreground and middle ground are part of the Litchfield terrace of Barrell, about 1,100 feet above sea level, and at the left in the far distance is the front of what he calls the Goshen terrace, the next higher, about 1,350 feet above sea level. The explanation offered for these features is as follows: The emergence of the land after the late Tertiary submergence was marked by alternate rapid uplifts and long periods of rest in which the land stood at one elevation and was subjected to marine erosion. There are in the Southington-Granby area three terraces, each facing the sea, at elevations of 880 to 920 feet, 1,100 to 1,140 feet, and 1,340 to 1,380 feet above sea level. The lowest has been named the Prospect terrace by Barrell because it is well developed in the town of Prospect. The middle and upper terraces are named in the same way for the towns of Litchfield and Goshen. In the northern part of Hartland there is a plateau of 3 or 4 square miles that is part of the Goshen terrace. In southern Hartland, Barkhamsted, Granby, and New Hartford there are similar fragments of the Litchfield terrace. The best preserved of the terraces is the Prospect terrace, extensive remnants of which exist in Burlington, Harwinton, Plymouth, Bristol, Wolcott, and Prospect. Other terraces, both higher and lower, are found elsewhere in the State.

Since the formation of the terraces and their exposure to erosion by elevation they have been deeply trenched by streams. Only a small part of their original surface is preserved. Most of the detail of the

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[10] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, p. 20, 1906.

[11] Barrell, Joseph, Piedmont terraces of the northern Appalachians and their origin: Geol. Soc. America Bull., vol. 24, pp. 688-691, 1913.

A. VIEW LOOKING NORTHWEST FROM NORTHEASTERN PART OF HARWINTON.

Showing dissected plateau and, in the distance, a scarp of a higher plateau.

B. STRATIFIED DRIFT IN PEQUABUCK VALLEY, 1½ MILES EAST OF TERRYVILLE STATION.

topography is due to this erosion, but much of it is due to ice action. During the glacial epoch the continental ice sheet that overrode most of the northern United States covered New England completely. It was of great thickness, and as it moved slowly southward it remodeled the topography by scraping away the surface accumulation of decayed rock, by breaking off and grinding down projecting ledges of rock, and by redepositing the débris. The major features of the topography were left unchanged, but the details were greatly altered. The soil mantle of decayed rock was replaced by unconsolidated mantle rock of two types—till and stratified drift. The till is of moderate thickness, and its surface is about the same as the general surface of the bedrock below. The stratified drift has several forms of topographic expression—flat outwash plains, long esker ridges, and hummocky kame areas.

During the Recent epoch—that is to say, since the final recession of the ice sheet—there has been no great geologic change. Small amounts of alluvium have been deposited in stream valleys, some swamps have been filled and some lakes changed to swamps by the deposition of sediment, and there has been slight erosion over the whole area, but the changes are in general imperceptible.

WATER-BEARING FORMATIONS.

The water-bearing formations of Connecticut may be divided into two classes—bedrock and glacial drift. The bedrocks are the underlying consolidated, firm rocks, such as schist, granite, trap, and sandstone, and they are exposed at the surface only in small, scattered outcrops. The glacial drift comprises the unconsolidated, loose materials, such as sand, clay, and till, that form the surface of most of the State and overlie the bedrocks. These materials are by far the more important source of ground-water supply and are of two chief varieties—till, also known as "hardpan" or "boulder clay," and stratified drift, also known as "modified drift" or "glacial outwash."

On the geologic map (Pl. II) are shown the areas occupied by till and stratified drift, as well as the outcrops of bedrock. The Triassic sandstone, the trap, and the crystalline rocks are differentiated, but no attempt was made to separate the eight well-recognized varieties of the crystalline rocks found in the Southington-Granby area. The outcrops of bedrock are indicated as small patches, which have roughly the shape of the actual outcrops but most of which are disproportionately large because of the small scale of the map. Inasmuch as in the field work it was necessary to follow the roads many outcrops in the spaces between the roads may have been unmapped.

GLACIAL DRIFT.

TILL.

Till, which is an ice-laid deposit, forms a mantle over the bedrock of much of Connecticut. Its thickness is in general from 10 to 40 feet but in places reaches 60 or 80 feet. The average thickness of the till as penetrated in 64 drilled wells in the Southington-Granby area is 23.7 feet.

The till is composed of a matrix of the pulverized and granulated fragments of the rocks over which the ice sheet passed, and of larger pieces of the same rocks embedded in the matrix. The principal minerals are quartz, clay, feldspar, and mica, but small amounts of their decomposition products and of other minerals are also found. There has been little chemical decomposition and disintegration of the till, and it has in general a blue-gray color. Near the surface, however, where the iron-bearing constituents of the matrix have been weathered, the color is yellow or brown. Where the material is in large part derived from the red Triassic rocks the till has a red or red-brown color.

The boulders of the till are characterized by their peculiar subangular shapes with polished and striated facets. Many of the boulders have facets that are in part concave where spalls have been flaked off as the boulders were pressed together in the ice. The boulders are very abundant and are scattered over the fields and in cut banks. In any bank or field there are likely to be a number of different varieties of rocks. There are many boulders of clear or brown-stained quartzite to which the name "hardheads" is often given. Many of these have been transported from localities in Massachusetts, where this variety of rock underlies considerable areas. They show something of the direction of movement of the ice, as do also the trap-rock boulders.

Some of the till is very tough, as is indicated by the popular term "hardpan" often applied to it. The toughness is in part due to its having been thoroughly compacted by the great weight of the ice sheet, and in part to the interlocking of the sharp and angular grains. It seems probable, however, that the more soluble constituents of the matrix have to some extent been dissolved by the ground water circulating through it and have been redeposited in such a way as to cement the particles together.

The relative amounts of the different sizes of material are shown in the following table.[12] The material treated by mechanical analysis is the fine earth that remained after the coarse gravel and boulders had been removed.

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[12] Dorsey, C. W., and Bonsteel, J. A., Soil survey in the Connecticut Valley: U. S. Dept. Agr. Div. Soils Field Operations, 1899, p. 131.

Mechanical analyses of stony loams from Connecticut Valley.

	Diameter (millimeters).	1	2	3	4
Gravel	2 to 1	2	12.45	5.26	3.05
Coarse sand	1 to 0.5	3.35	11.86	8.66	3.85
Medium sand	0.5 to 0.25	8.60	13.98	18.83	8.22
Fine sand	0.25 to 0.1	31.25	14.78	21.00	11.53
Very fine sand	0.1 to 0.05	34.22	17.51	18.83	29.82
Silt	0.05 to 0.01	4.35	8.20	8.70	21.26
Fine silt	0.01 to 0.005	6.20	8.67	5.30	6.45
Clay	0.005 to 0.0001	6.57	10.23	10.87	12.20
Loss at 110° C		1.36	1.04	1.01	1.54
Loss on ignition		2.03	1.69	1.77	2.35

1. Triassic stony loam half a mile south of Bloomfield, Conn.
2. Triassic stony loam, Enfield, Conn.
3. Triassic stony loam 1½ miles south of Hazardville, Conn.
4. Holyoke stony loam 2 miles south of Ashleyville, Mass.

The first three analyses represent till derived from Triassic sandstones and shales; the fourth a till derived from crystalline rocks. The boulders and pebbles mixed with the fine earth (the matrix) constitute from 5 to 50 per cent or even more of the total volume.

The water-bearing capacity of the till is difficult to estimate for any large area because of its extreme variability. A small sample may be tested by drying it well, then soaking it in water until it is saturated, and finally allowing the excess to drain away. A comparison of the weight after drying with the final weight will show how much water has been absorbed. Gregory[13] made such an experiment on a typical mass of till collected near New Haven and determined that 1 cubic foot could absorb 3.46 quarts. In other words, the till is able to absorb water to the extent of 11.55 per cent of its total volume. Other samples would undoubtedly show higher and lower results, but this is probably not far from the average.

The pores of the till are relatively small, so that water does not soak into it very rapidly. On the other hand, the pores are very numerous and are able in the aggregate to hold a good deal of water, as is shown above. The fineness of the pores is a disadvantage in that it makes absorption slow, but it is at the same time an advantage in that it retards the loss of water by seepage. The till of Connecticut is more porous than that of many other glaciated regions, apparently because the hard, resistant rocks from which it was derived yielded grains of quartz and other siliceous minerals, rather than fine rock flour. This statement probably applies better to the till derived from the crystalline rock and the Triassic sandstones and conglomerates than to the till derived from the shales and shaly sandstones.

At many places there are lenses of water-washed and stratified material within the body of the unsorted and unstratified till. These

[13] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 139, 1909.

were presumably deposited by subglacial streams that existed but a short time before they were diverted or cut off by the advance of the ice sheet. These lenses are of considerable value where they happen to be cut by a well, as they in effect increase the area of till that drains into the well and so increase its supply. Well diggers often report that at a certain depth they "struck a spring." Such reports probably refer to cutting into lenses of this type.

The till has no striking topographic expression. The plastering action of the ice sheet by which it was deposited tended to give it a generally smooth surface. In a very few places there are ridges or terrace-shaped bodies of till—lateral moraines, built at the flanks of tongues of ice that protruded beyond the front of the main ice body. In some places the till was heaped up beneath the ice, much as sand bars are built on river bottoms, and now forms gently rounded hills called drumlins.

STRATIFIED DRIFT.

In contrast with the till, which was formed by direct ice action, s the stratified drift, which is a water-laid deposit. Stratified drift may have originated either within, on, under, or in front of the ice sheet. In Connecticut only subglacial and extraglacial stratified drift are found, and except for their topographic expression they are very similar.

Stratified drift is composed of the washed and well-sorted, reworked constituents of the till, together with some débris made by the weathering and erosion of bedrock. The water that did the work was, for the most part, the water produced by the melting of the glacier, but since glacial times the streams of the region have continued the process. The distinction between glacial stratified drift and more recent alluvium is hard to draw, and for the purposes of a ground-water study it is not essential. Toward the end of the glacial epoch the climate became very mild, and vast amounts of ice were melted. The relatively soft till was easy for the glacial streams to erode, and it supplied a great abundance of material. Presumably some of the streams flowed in sinuous subglacial channels in which they made deposits that have now become long, winding ridges called eskers. The water in some of the channels beneath the ice seems to have been under hydraulic head, as some eskers cross ridges and gullies regardless of the grades.

Where the débris-laden waters came to the edge of the ice sheet kames were made. Some of the material was carried beyond the front of the ice sheet and was laid down as an alluvial deposit in the valley. Not all the materials composing the wide outwash plains have been deposited by running water. There are also beds of finer material—clay and silt, rather than sand—that were laid down in

lakes and ponds which stood in shallow depressions in front of the ice.

The stratified drift consists of interlocking lenslike beds laid one against another in a very intricate and irregular way. Some of the lenses consist of fine sand, others of coarse sand, others of gravel, and still others of cobbles. Sand lenses are the most abundant. The material of each lens is rather uniform in size, but there may be a great difference between adjacent lenses. In general the finer materials form more extensive beds than the coarser. Some of the beds of clay and fine silt, though only an inch or two thick, have a horizontal extent of several hundred feet. Lenses of gravel may be 2 or 3 feet thick and not extend over 10 feet horizontally.

The sand lenses are composed almost entirely of quartz grains. In the gravel lenses are pebbles of many kinds of rocks. The clay beds contain true clay, thin flakes of mica, and minute particles of quartz and feldspar. In all the deposits there is iron which gives them brown colors.

The following table shows the character of the material:[14]

Mechanical analyses of stratified drift from Connecticut Valley.

	Diameter (millimeters).	1	2	3	4	5
Gravel	2 to 1	4.98	2.20	0.50	0.00	0.00
Coarse sand	1 to 0.5	11.31	7.51	1.51	Trace.	.29
Medium sand	0.5 to 0.25	33.41	33.50	7.96	.21	.40
Fine sand	0.25 to 0.1	33.75	32.05	23.27	1.50	.73
Very fine sand	0.1 to 0.05	10.82	13.50	41.82	19.55	5
Silt	0.05 to 0.01	2.09	4.47	9.15	33.67	32.57
Fine silt	0.01 to 0.005	1.03	1.75	6.32	28.54	29.10
Clay	0.005 to 0.0001	1.65	2.78	4.40	9.50	25.65
Loss at 110° C		.50	.80	1.92	2.60	2.17
Loss on ignition		.80	1.30	3.68	4.75	3.53

1. Coarse, sharp sand, 2 miles southeast of Bloomfield.
2. Sandy loam, southwest of Windsor.
3. Fine sandy loam, half a mile northeast of South Windsor.
4. Recent flood-plain deposits, three-quarters of a mile southeast of Hartford.
5. Brick clay from glacial lake beds, Suffield.

The most striking difference shown by a comparison of this table with the table of mechanical analyses of till samples on page 25 is that in each sample of stratified drift two or three sizes make up almost all the material, whereas in the till there is a wider diversity of sizes, even exclusive of the boulders, which are neglected in the analyses.

The topographic form assumed by most of the stratified drift is that of a sand plain, which may be modified by terraces, by valleys cut into it, or by kettle holes. In the highlands small bodies of stratified drift form eskers—long winding ridges, 10 to 40 feet high—in some

[14] Dorsey, C. W., and Bonsteel, J. A., Soil survey in the Connecticut Valley: U. S. Dept. Agric. Div. Soils Field Operations, 1899, pp. 132, 134–136, 138.

places with narrow crests and in others with flat tops up to 100 feet wide, and generally with steep flanks. In the lowlands there are kame areas of stratified drift which consist of irregularly scattered hillocks and hummocky short ridges.

CRITERIA FOR DIFFERENTIATION OF TILL AND STRATIFIED DRIFT.

No hard and fast rules can be laid down for determining whether the mantle rock at any point is till or stratified drift, and the decision is reached only after weighing several factors. The presence of clear bedding is indubitable evidence that the deposit is stratified drift, but it can be seen only in fresh excavations. Till areas in general contain numerous stone walls, which are lacking in most stratified-drift areas. In case of doubt the shape of the boulders in the walls should be studied. Till areas have less striking topographic forms than stratified-drift areas, which show broad plains with terraces and kettle holes, or kames and eskers. Because of their peculiar ground-water conditions the stratified-drift areas are likely to have many pines, both white and yellow, cedars, and scrub oaks, with an undergrowth of sweet fern and "poverty" grass. There are no outstanding floral characteristics in the till areas.

OCCURRENCE AND CIRCULATION OF GROUND WATER.

Some of the water that falls as rain or melts from snow soaks into the ground. A surface layer of sand or gravel or a thick mat of leaf mold or of needles, as in woods, probably affords the most favorable condition for high absorption. Steep slopes are unfavorable, because the rain runs off from them rapidly and completely. When the ground is frozen it becomes almost impervious and absorption is at a minimum. Heavy rains concentrated in a short time will in general result in less absorption than an equal amount of rain spread over a longer time.

The amount of water that may be absorbed is great. With a rainfall of 48 inches, each acre would receive in the course of a year over 1,300,000 gallons of water. If one-fourth of this were to soak into the ground and be concentrated in a single spring, that spring would discharge an average of six-tenths of a gallon a minute throughout the year.

The movement of water through the ground is due for the most part to gravity. The water sinks through the pores of the soil until it reaches an impervious bed or the ground-water level and then perforce it moves laterally. Lateral movement over great distances does not occur in Connecticut, because the porous soils are cut into small, discontinuous areas by the numerous ledges of bedrock. Inasmuch as the porous-soil cover over the bedrock is in general not

very thick the direction of movement is for the most part the same as the slope of the surface of the ground. In the flat plains of stratified drift this rule holds less rigidly than on irregular till-covered slopes. The velocity of circulation depends on the steepness of the slopes and the porosity and permeability of the soils. Porosity is the ratio of the total volume of the voids between the grains to the total volume of the substance and is not concerned with the size of the pores. Permeability is the ability of the material to transmit water and depends more on the size of the individual pores. Large pores like those of gravels favor rapid circulation of ground water. Fine clays may have as high a porosity as the gravels, but because of the interstitial friction in the fine pores they are virtually impermeable.

The rise of water through the soil by capillary action is not an important factor in the problems of domestic and public water supply. It is of moment, however, in making water accessible to vegetation.

At some depth the pores of the soil are saturated with water. The rains and melting snows have continued to supply water to the soil and would have saturated it throughout but for the lateral escape of the excess. The top of this saturated zone is known variously as the ground-water surface, the ground-water level, or the water table.

The water table is high—that is, near the surface of the ground—in regions and seasons of high precipitation, where the soil cover is thin and discontinuous and where the surface is level or gently sloping. It is likely to be particularly high in small deposits of mantle rock filling minor depressions or basins in the bedrock. Along the margins of streams, lakes, and swamps the water table is at the surface. It is low in arid regions, in times of drought, on steep slopes, and in areas where the soil mantle is thick. The depth to the water table fluctuates with the seasons and may be increased by drainage of wet grounds, by heavy draft on wells, and to a slight extent by transpiration from vegetation. The improvements made by man on farms and the engineering works in cities tend to lower the water table. In Connecticut the greatest fluctuation of the water table is on steep slopes from which the water drains readily. In such situations there is also a rapid though often temporary replenishment of the ground water after rains.

No general horizons for water-bearing beds are known in Connecticut, with the exception of the water table in the unconsolidated mantle rocks and the water table formed in many places just above the bedrock by the blocking off of the downward movement of the water by the relatively impervious bedrock. Many wells dug to solid rock and blasted a few feet into it take advantage of this source of supply. This water bed also feeds water into the fissure system of the bedrocks.

The till and stratified drift show great contrasts in texture and therefore in their ability to hold up the water table and to transmit water. Because of its greater permeability the stratified drift absorbs water more readily than the till, but it also loses water more rapidly. In most regions the water table is nearer the surface in valleys and lies deeper on the hills, as shown in figure 9. In much of Connecticut, however, where the valleys are filled with stratified drift and the hills are capped with till, the anomalous reverse condition exists. Because of the much slower rate at which the water percolates through the till the water table is held up nearer the surface on the hills than it is in the valleys. This condition is diagrammatically shown in figure 10.

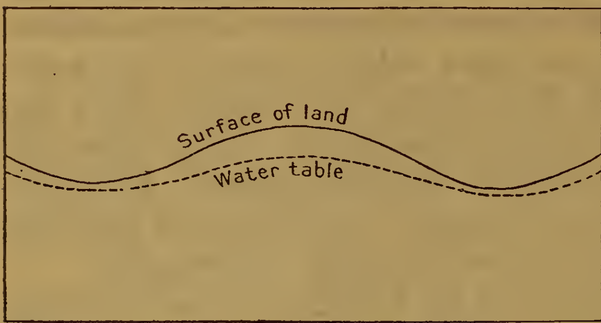

FIGURE 9.—Diagram showing the usual relation of the water table to hills and valleys.

TRIASSIC SEDIMENTARY ROCKS.

DISTRIBUTION.

A belt 4 to 8 miles wide along the east side of the Southington-Granby area is underlain by Triassic rocks. It occupies 195 square miles, or nearly 40 per cent of the whole area.

LITHOLOGY AND STRATIGRAPHY.

The lowest of the Triassic beds lie unconformably on the upturned edges of the crystalline rocks along the western border of the belt. The relation is shown in the structure sections across Avon, Canton, Simsbury, and Southington. (See figs. 18, 22, and 30.)

The Triassic sediments may be divided into four parts separated by trap sheets, as is shown in the stratigraphic column given in figure 11, compiled from the descriptions given by Davis.[15] The physical differences between the four parts are slight, and they can in general be separated only by their position relative to the trap sheets. The names are derived from their positions in the stratigraphic column.

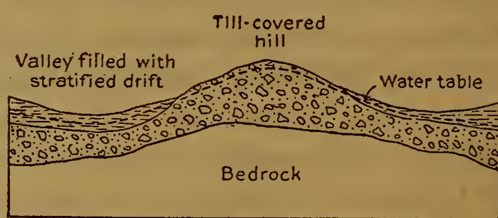

FIGURE 10.—Diagram showing the relation of the water table on hills to the water table in valleys in glaciated regions.

The following description of the Triassic sediments is taken from the excellent one given by Rice and Gregory:[15a]

[15] Davis, W. M., The Triassic formation in Connecticut: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, pp. 27–29, 1898.

[15a] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, pp. 163–165, 1906.

The rocks would naturally be characterized in a broad way as red sandstone. The sandstones, sometimes coarse, sometimes fine, consist mainly of grains of quartz, feldspar, and mica resulting from the disintegration of the older rocks which form the wall of the trough in which the sandstones were deposited. The prevailing red-brown colors of the sandstones are due not to the constituent grains but to the cementing material, which contains a large amount of ferric oxide. * * * While the name sandstone would properly express the prevalent and typical character of the rock, the material is in some strata so coarse as to deserve the name of conglomerate, and in others so fine as to deserve the name of shale. In the conglomerates the pebbles may be less than an inch in diameter, but they are sometimes much coarser. In some localities occurs a rock which has been called "giant conglomerate," in which some of the boulders are several feet in diameter. The conglomerates occur chiefly near the borders of the Triassic areas, and in these it is especially easy to recognize rocks from the disintegration of which the pebbles have been derived. In general, it may be said that the pebbles in any particular area are derived from rocks in the immediate vicinity. The conglomerates in the Connecticut Valley area are obviously derived from the gneisses, schists, and pegmatites, which are the prevalent rocks of the highlands. * * * The shales, like the sandstones and conglomerates, are prevailingly red, owing their color likewise to the presence of ferric oxide. Some strata of shale, however, contain in considerable quantity hydrocarbon compounds derived from the decomposition of organic matter. These bituminous shales are accordingly nearly black. In the Connecticut Valley area there are two thin strata of these bituminous shales, which have been shown, by careful search for outcrops, to have a very wide extent.

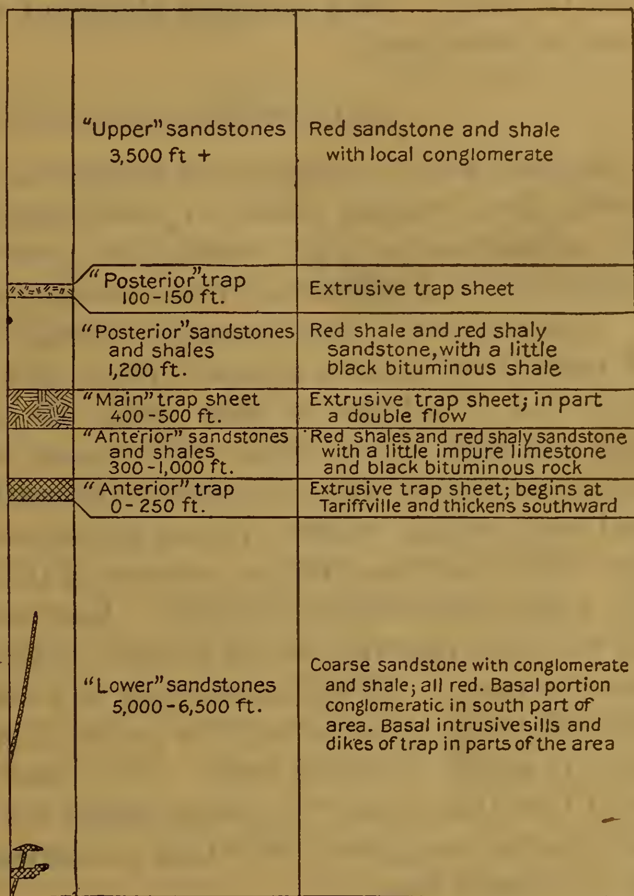

FIGURE 11.—Columnar section of the Triassic formations of Connecticut.

There is also a small amount of impure green and gray limestone in the Triassic sediments. The red sediments, however, are dominant. The material and structure of the beds vary greatly and the changes in the rock are very abrupt. The stratification is uneven and irregular, and the beds are wedge-shaped or lenslike rather than uniformly thick over wide areas.

Although the beds were originally horizontal and in continuous masses, they have been tilted 15° or 20° to the east and have been

broken into blocks. The nature of the forces that caused this faulting into blocks has not been conclusively determined. They opened many joints and fissures along which there was little or no movement. These joints are in general parallel to the bedding or nearly at right angles to it, though joints may be found with every conceivable inclination. The sandstones and conglomerates have more abundant and more extensive joints than the shales, for they are rigid and relatively brittle rather than plastic and tenacious. The joints are rarely more than 50 feet apart and in general are found at intervals of 2 to 8 feet. They are more abundant and wider near the surface than at some depth.

OCCURRENCE OF GROUND WATER.

Ground water occurs in the sedimentary rocks in four ways—in pores, along bedding planes, in joints, and along fault lines. Though its original source is the rainfall, it is for the most part derived by infiltration and percolation from the saturated glacial drift above.

Water in pores.—The sandstone, shale, and conglomerate consist of particles of quartz, feldspar, mica, and other less abundant minerals and of pebbles of older rocks, all cemented together by fine clay and films of iron oxide. The spaces between the grains are not completely filled with the cementing material but are partly open and may contain water. In the aggregate large quantities of water are held in this way, but on account of the smallness of the openings the water is not readily given off. Bare outcrops, as in quarries, are for the most part dry on the surface, though the interior of the rock may be moist. In the sandstones and conglomerates the water in the pores is given off slowly to joints, from which it may be recovered by means of drilled wells. The shales have very fine pores and yield but little water. In some places the shales are so impervious as to act as restraining beds that concentrate the water in the pores of the coarser beds.

Water in bedding planes.—There is a tendency for the water in the pores to be concentrated in and transmitted along the lower parts of the coarser beds, where they rest on finer and relatively impervious beds. It is probable that a few of the wells drilled in Triassic rocks draw their supplies from such horizons.

Water in joints.—Joints, which divide all the rocks into polygonal blocks of various sizes and shapes, are the chief source of water in the bedrocks of Connecticut. They are more abundant and wider in sandstone and conglomerate than in shale. These extensive crevices are better water bearers than the pores, because they are larger and offer less capillary resistance to the circulation of water, because they draw on and make available the supply of water stored in the pores, and because they are of relatively great extent. Most

of the drilled wells and a few of the dug wells in the Triassic area draw on the joints for their supplies.

Water in fault zones.—The faults that break the Triassic rocks of Connecticut into great fault blocks are not single fractures, but rather zones comprising many parallel planes along which movement took place. Because of the great number of water-bearing joints in such zones, wells drilled along fault lines are likely to yield very large supplies of water.

TRIASSIC TRAP ROCKS.

DISTRIBUTION.

Trap rock is found under two conditions in the Southington-Granby area. Along the east boundary there are three extrusive sheets which were gently poured out as lavas and interrupted the deposition of the Triassic sediments. Their thickness and relative position in the stratigraphic column are shown in figure 11. The middle sheet is called the "Main" sheet, because it is the thickest and makes the most prominent cliffs. The eastward tilting of the Triassic rocks made the lower sheet crop out on the west or face side of the "Main" sheet, and for this reason it is called the "Anterior" sheet. Similarly, the upper sheet is called the "Posterior" sheet. The "Main" sheet follows very closely the east boundary of the Southington-Granby area for most of its length. Just to the west and a little lower are outcrops of the "Anterior" sheet, which does not, however, extend far north of Tariffville but pinches out. The "Posterior" sheet is found nowhere in this area except in the eastern parts of the towns of New Britain and Farmington.

Near the contact of the basal Triassic sediments with crystalline rocks are intrusive masses of trap—sills, dikes, and irregular masses that were forced into the sediments after they were already buried. The sills in general are extensive flat bodies that follow the bedding, though in some places they cut across it. One sill extends from a point near Milldale southward through Cheshire and Prospect to New Haven, and another from Unionville northward through Avon, Canton, Simsbury, and Granby. These sills range in thickness from less than 100 to more than 400 feet. The dikes are thinner and range from 10 to 40 feet. There are several in Cheshire, of which the so-called Bristol ledge, 4 or 5 miles long, is the most conspicuous. There are also a few trap dikes in the crystalline rocks of the highland—for example, in the southwest corner of Wolcott.

LITHOLOGY.

Except for the difference in the position in which they were first formed, the two classes of trap are essentially alike. They are dense,

heavy dark-gray to nearly black rocks. The intrusive traps are somewhat coarser and more perfectly crystallized than the extrusive traps. Sometimes the names "diabase" and "basalt" are used to differentiate the intrusive and extrusive traps.

Like the sedimentary rocks in which they are inclosed the traps are cut by numerous joints, some of which were made by the initial cooling and shrinkage of the rock and others by the jarring incidental to the Jurassic faulting. As the shrinkage and cooling joints tend to be normal to the planes of cooling of the rock masses, the joints of sills and sheets are generally vertical and those of dikes horizontal. The joints are more abundant near the margins of the masses.

OCCURRENCE OF GROUND WATER.

Trap rocks have a twofold bearing on the occurrence of ground water. The joints may contain water, and the sheets may act as impervious layers to restrain the circulation. Trap rocks have a very low porosity and carry virtually no water in pores, and of course they contain no water corresponding to that along bedding planes of sedimentary rocks. Water circulates through the joints and fault zones just as in sandstones, but in general less abundantly. Evidence of this circulation is given by the yellow and brown stains of iron oxide along the joints, due to the oxidation and hydration of the iron-bearing minerals by the water.

In a few places a sheet of trap rock above a relatively porous sandstone layer makes it a small artesian basin. The well belonging to the Traut & Hine Manufacturing Co., in New Britain (see p. 152), seems to have obtained a flow from such a horizon. It is impossible to predict that a well in a similar situation will obtain artesian water, however, for there may be faults and joints that cut the trap in such a way as to allow the water to escape from below.

The immediate source of the water in the trap rock is the water in the formations with which it is in contact; this water enters it through the network of interconnecting joints.

CRYSTALLINE ROCKS.

DISTRIBUTION.

Crystalline rocks, so named because their constituent mineral particles are crystalline rather than fragmental, underlie the western three-fifths of the Southington-Granby area—about 308 square miles. The extent of these rocks is identical with that of the highland physiographic provinces, because the characteristic features of the province depend in large part on the resistance of these rocks to erosion.

LITHOLOGY.

There are three types of crystalline rocks in the Southington, Granby area—schists, gneisses of igneous origin, and gneisses of complex origin. Each of these types is represented by two or more formations.

Schists.—Typical schists are metamorphosed sandstones and shales which in turn are consolidated sands and muds. The mountain-making movements to which this region has been subjected squeezed up and folded the sedimentary rocks. At the same time the great change in temperature and pressure metamorphosed the rocks completely; the quartz sand grains were crushed and strung out, and the clayey material was changed to crystalline mica. The mica flakes were turned to roughly parallel positions and so give the rock a pronounced cleavage, known as schistosity. Though other materials are present quartz and mica are the most abundant. The Berkshire (Ordovician) schist of western Hartland and Barkhamsted and of northwestern New Hartford and the Hoosac ("Hartland") schist (also Ordovician), which extends the whole length of the margin of the highland, are of this type.

Gneisses of igneous origin.—In connection with the dynamic metamorphism of the region were intruded great masses of molten rock. They have been metamorphosed like the schists but to a much smaller degree. The dark minerals are somewhat segregated and parallelly oriented, so that the rock has a fair cleavage. There are five formations of this general type in the Southington-Granby area. Typical granite gneisses, composed essentially of quartz, feldspar, and mica, are the Bristol granite gneiss,[16] which is found in half of Bristol and small areas in Plymouth and Burlington; the Collinsville granite gneiss, in Canton and Avon; and the Thomaston granite gneiss, which occurs in small patches in Plymouth and Harwinton. The Prospect porphyritic granite gneiss differs from these in that some of the feldspars are much larger than the others and give the rock a porphyritic character. A small area south of Plymouth village is underlain by amphibolite, a gneissic rock composed essentially of feldspar and hornblende.

Gneisses of complex origin.—The Waterbury gneiss, in Harwinton, Burlington, Plymouth, Wolcott, and Prospect, and the Becket granite gneiss, in Harwinton, New Hartford, Barkhamsted, and Hartland, are of complex origin and are in a way intermediate between the two types described above. Certain parts of the schist have been very

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[16] Five gneiss formations (Waterbury gneiss, Bristol granite gneiss, Collinsville granite gneiss, Prospect porphyritic granite gneiss, and Thomaston granite gneiss) are here referred to under the provisional names given to them on the preliminary geologic map of the State by Gregory and Robinson (Connecticut Geol. and Nat. Hist. Survey Bull. 7, 1907). These names are used for convenience and may differ from those which will be finally adopted by the United States Geological Survey.

extensively injected on a minute scale with igneous material, so that its character is materially altered. The thin intrusions for the most part follow the planes of schistose cleavage and somewhat obscure them.

OCCURRENCE AND CIRCULATION OF GROUND WATER.

Water in lamellar spaces.—In the schists and to some extent in the gneisses of complex origin, but not in the granite gneisses, there is a little water in the spaces between the crystalline grains and flakes. Most of the openings are flat, thin, and not extensive, and few of them are interconnected. In the crumpled schists there are small tubular openings along the furrows and ridges. The chief function played by schistose structure in promoting the circulation of ground water is that its weakness in one direction gives rise to numerous joints.

Water in joints and along faults.—The forces that caused metamorphism also made many fractures in the rocks. The fractures are even more numerous in the crystalline rocks than in the sandstones, but they bear water in the same way. Inasmuch as it is virtually impossible to trace faults in the crystalline rocks they will be considered here only as compound or enlarged joints in which circulation is especially vigorous.

There are two principal sets of joints; those of one set are nearly horizontal, and those of the other nearly vertical. The vertical joints, according to Ellis,[17] are from 3 to 7 feet apart where jointing is well developed. In some sheeted zones 1 to 15 feet wide the joints are spaced at intervals of 3 inches to 2 feet. In other places they are 100 feet apart. Though the spacing increases with depth it is on the average less than 10 feet to a depth of 100 feet. Ellis finds that for the first 20 feet the horizontal joints are 1 foot apart on the average; for the next 30 feet they average between 4 and 7 feet; and from 50 to 100 feet in depth they are from 6 to 20 feet or more apart. The intersecting horizontal and vertical joints form a very complicated system of channels through which water may circulate. Water is supplied to the network of channels by percolation from the overlying mantle of soil.

ARTESIAN CONDITIONS.

The word "artesian" is derived from the name of the old French province of Artois, in which wells of this type first became widely known. Originally the term was applied only to wells from which water actually flowed, but now it is applied to wells in which because of hydrostatic pressure the water rises above the level of the point

[17] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 65, 1909.

at which it enters the well. The term is sometimes improperly used for any deep well whether the water is under pressure or not. The question whether an artesian well will flow or not depends as much on the elevation of its mouth as it does on the pressure at which the water enters the drill hole.

The requisite conditions for artesian waters are the existence of a porous bed or fractured rock through which water may flow; having an outcrop (the imbibition area) where water may soak into it, at a higher elevation than the well; relatively impervious strata above and below the pervious bed to prevent escape of the water and sufficient precipitation on the imbibition area to fill the pervious bed and keep it full. In Connecticut these conditions may be fulfilled in two principal ways, but in general there are so many faults and open joints that the water loses most of its head and flowing wells are few. The faults and joints prevent the fulfillment of the

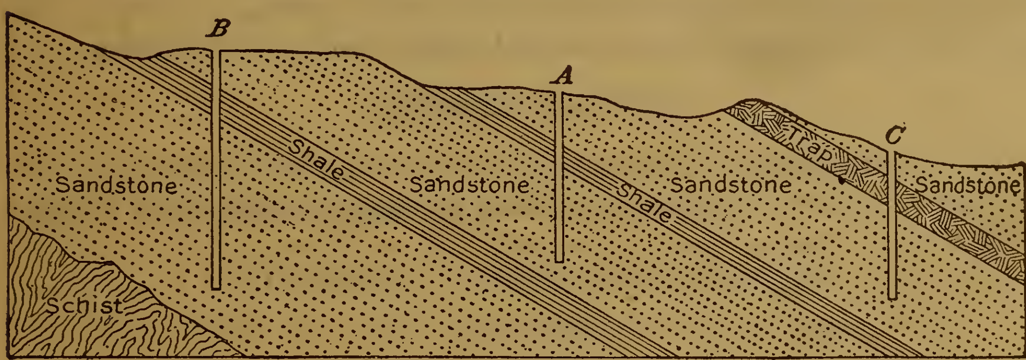

FIGURE 12.—Diagram showing conditions under which artesian waters may exist in the sandstone and shale of Connecticut.

condition of restraining beds above and below the pervious bed. The great majority of the drilled wells, however, are artesian, for the water in them rises considerably above the point of entrance.

A few wells pass through beds of relatively impervious shale and draw water from porous sandstones, as shown in figure 12. The underlying restraining member may be either a shale bed, as at *A*, or it may be the dense crystalline mass on which the Triassic beds rest, as at *B*. According to Gregory and Ellis,[18] the black shales of the "anterior" and "posterior" shales are particularly efficacious restraining layers. Within the limits of the Southington-Granby area, however, the black shales are to be found only in New Britain and Farmington. In general the beds of the Triassic sedimentary rocks are not of sufficient lateral extent to form important reservoirs. In a few wells, such as that of the Traut & Hine Manufacturing Co., New Britain, a sheet of trap rock may act as a restraining member

[18] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 109, 1909.

and form a small artesian basin. This condition is diagrammatically illustrated at *C* in figure 12. (See also fig. 25, p. 150.)

Many more wells draw water from the network of fissures than from the pores of sandstones and conglomerates. In some of these rocks there are no connecting joints that might discharge water to the surface below the wells; in others the fissures are so tight that they do not discharge water readily. Other wells draw water from fissured rock that is overlain by a blanket of till which acts as a restraining member.

SPRINGS.

A spring, in the broadest sense of the word, is a more or less definite surface outlet for the ground water. Springs are formed wherever the surface of the ground is so low that it reaches the water table. A well is in a sense an artificial spring, for it is made by artificially depressing the ground surface till it reaches the water level. There are many possible conditions which may cause springs, but they may all be grouped under three principal heads, as described below.

SEEPAGE SPRINGS.

The normal method of escape of water from the ground is by slow seepage in saturated areas on hillsides and along swamps and streams. This process may go on over a wide space if the soil is of uniform texture, or it may be concentrated in a small body of more porous soil. The former process is diffused seepage; the latter produces a true spring, and to this class belong the so-called "boiling springs," in which the water enters with sufficient force to keep the sand bottom in gentle motion. In a spring of either class the supply may be concentrated by the excavation of a collecting reservoir.

Seepage springs are very likely to be found in small swales cut back into a slope. It seems probable that the flow of water is the primary cause of the excavation of the swales, but the swales secondarily tend to concentrate the flow. Areas of diffused seepage tend to develop into true springs by such a process.

STRATUM SPRINGS.

Stratum springs are those in which an outcropping or only slightly buried ledge or layer of impervious material interrupts the flow of ground water and forces it to the surface. Springs of this type may be made by a ledge of rock underlying saturated drift, by a bed of sedimentary rock having less porosity than the adjacent bed, or by a body of stratified drift overlying till. Many of the springs of the Southington-Granby area are of this type.

In the Farmington-Quinnipiac valley the slopes are covered with till and the floor with stratified drift. Many springs are found at the contact of the till and stratified drift. This is an anomalous

condition, for the porous stratified drift seems to force out water from the less porous till. One possible explanation is that there is a ledge of rock near the surface beneath the boundary of till and drift. Inasmuch as the stratified drift is a water-laid deposit, it seems probable that the stream cut away most of the till before laying down the stratified material.

FAULT AND JOINT SPRINGS.

Faults and joints greatly facilitate the circulation of water through rocks, and where they reach the surface they may supply springs. Some faults carry a good deal of water under considerable pressure and may be considered analogous to artesian wells.

RELATION OF SPRINGS TO WELLS.

Springs that have been improved by excavation to a considerable depth are hard to distinguish from wells that have obtained water at moderate depths. In this report the criterion taken for classifying such springs is the original condition of the ground. If it appears to have been a wet or springy spot, the term "spring" is applied regardless of the depth of excavation. If the surface was dry in the first place, the term "well" is applied no matter how shallow the depth at which the water table was found.

RECOVERY OF GROUND WATER.

DUG WELLS.

CONSTRUCTION.

Dug wells are constructed by digging holes in the ground deep enough to extend below the water table. The excavation is generally made 8 or 10 feet in diameter, and in it is built a lining of dry or mortared masonry or brickwork, concrete, vitrified tile, or planking. As the well is walled up the space outside the lining is filled. The filling should be of some porous material such as coarse sand or gravel, but most well diggers pay no attention to this point. Most dug wells when completed are 3 to 5 feet in diameter, though some are much larger; and they range in depth from a few feet up to 80 feet. The average depth of the dug wells measured in the Southington-Granby area is about 20 feet, and they contain on an average 5 feet of water.

Some wells are specially constructed so as to draw on a large area. The well of J. H. Sessions & Sons in the southeastern part of the city of Bristol has at the top a vertical line of tile 2 feet in diameter that extends 6 feet underground and rests on the domed roof of a bricked chamber 6 feet in diameter and 16 feet high. Seven iron pipes 4 inches in diameter and 10 to 25 feet long radiate from the bottom of

the chamber and draw water from a roughly circular area of gravel about 35 feet in diameter. It is believed that this well will yield 40 gallons a minute for a whole day's run.

LIFTING DEVICES.

BAILING DEVICES.

A number of different devices are in use for raising water from dug wells. All are modifications of a simple bucket for bailing out water, of the displacement pump, or of the siphon.

The most primitive method is bailing with a dipper in very shallow wells, or with a bucket hung from a rope in deeper wells. In some places the rope is replaced by a light pole with a snap ring by which the bucket is held. The devices are not only inconvenient and laborious but insanitary. Most wells used in this way have no covers, so that there is every opportunity for the entrance of leaves, sticks, dust, small animals, and other foreign matter. Moreover, the handling of the bucket may transfer objectionable matter from the hands to the water. There are various modifications which though not much more sanitary are less laborious.

In the typical "one-bucket rig" there is over the well a gallows-like framework from which is hung a pulley. The rope is fastened at one end to the curbing and at the other to the bucket. The "two-bucket rig" is similar except that it has a bucket at each end of the rope, and the necessity of sending down the bucket before drawing water is eliminated. The curbing for either of these rigs should be tight and have a cover or roof.

In the "sweep rig" the bucket is hung by a rope or slender pole from the small end of a sweep 15 to 40 feet long. The sweep is pivoted at a crotch in a convenient tree or over a pole set firmly in the ground, and has at its butt end a counterbalancing weight of some sort.

In the "wheel and axle rig" the rope from the bucket winds around a wheel 2 to 4 feet in diameter which has a grooved face to keep the rope from slipping off. The wheel is carried on an axle 4 to 8 inches in diameter suspended above the well and a little off center. Wound around the axle is a second rope to which a heavy stone or block of iron is hung. The greater weight of the stone acting on the axle counterbalances the lesser weight of the bucket acting on the large wheel.

In the "windlass rig" the rope from the bucket winds around a drum 5 or 6 inches in diameter to one end of which a crank is attached. The windlass is set over the well, and on the drum are flanges to keep the rope from running off. Many are provided with a ratchet to prevent the bucket from falling back and with a brake to use in lowering the bucket. Some of the brakes are of the band type, and some are merely boards hinged at one end to the side of the curbing

and bearing near the middle on the drum. In some windlass rigs the rope is replaced by chains either of the ordinary sort or flat linked, by leather straps, or by flat straps of mild brass.

The "counterbalanced rig" is a modification of the windlass rig in which the rope instead of winding around a drum passes over a pulley carried on the crank axle. One end of the rope has a bucket and the other a weight that more than counterbalances the empty bucket but is lighter than the full bucket. In some rigs a chain and suitably notched pulley are used instead of a rope and smooth pulley.

The rigs described above, as they are generally installed, are open to criticism on sanitary grounds. At far too many wells the open curbs and inward-sloping surrounding surface allow access of foreign matter to the water, and moreover there is danger of pollution from the handling of the bucket and rope. All the devices are much safer when the curbs are tight and hinged covers are provided which may be kept closed except while water is being drawn. It is also a good plan to bank up the earth around the well curb or to build a concrete apron around it so that surface water and drippings will flow away from the well. With the wheel and axle rig and the windlass rig it is possible to avoid the transfer of objectionable matter from the hands by using an automatic tipping and filling bucket, an ordinary bucket equipped with a flap valve in the bottom to facilitate filling, and a pair of metal prongs fastened opposite one another on the rim. For a few feet next to the bucket the rope is replaced by a flat chain that as it rolls onto the windlass drum turns the bucket so that one or the other of the prongs catches a cross rod inside the curb. By winding up a little more the bucket is tipped and emptied into a spout. With this arrangement it is unnecessary to open the curb, which may be made thoroughly tight against foreign matter, or to handle the bucket except on rare occasions for repairs.

The arrangement of the windlass at one well that was visited is worthy of description. The well is just outside the house, and the windlass crank extends through the wall into the house. The water is dumped from an automatic tipping bucket into the spout, from which it flows into a piece of galvanized-iron conductor pipe that also goes through the wall and delivers the water indoors. In winter the discomfort of drawing water is reduced to a minimum.

PUMPS.

Among the principal classes of pumps are displacement pumps, impeller pumps, bucket pumps, and air lifts. Displacement pumps are of two principal sorts—pitcher pumps and deep-well pumps. Both consist of a cylinder in which a piston moves. At the bottom of the cylinder and in the piston are valves that open upward. When the piston is raised water rushes into the cylinder from below, and

when the piston is shoved down the water rises through its valve. Repetition of the movement raises the water in successive small masses. In a pitcher pump the working cylinder is at the top of the pipe, above the ground, and the pump is not closed in above the piston. In a deep-well pump the working cylinder is at some depth and is connected with the delivery pipe by a closed covering or cap. On top of the delivery pipe is a standard to carry the pump handle, and a rod runs down through the delivery pipe to the piston. Some deep-well pumps are double acting—that is, they have two pairs of valves so arranged that water is pumped on both the rising and the descending stroke of the piston instead of only on the rising stroke. Displacement pumps, theoretically, ought to work when the cylinder is 32 feet or less above the water level, but in practice it is found that on account of leaks and friction they will not work when the suction lift is more than 25 to 28 feet. These figures apply to pumps working

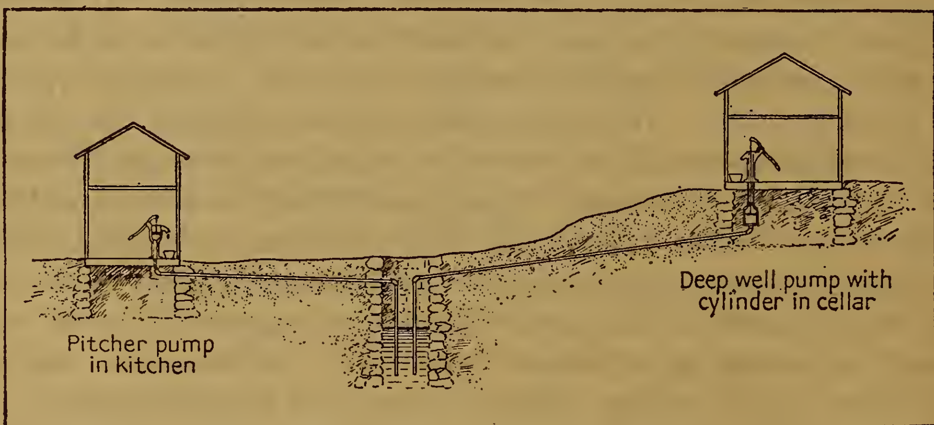

FIGURE 13.—Diagram showing two types of installation of "house pumps."

at sea level, but they must be decreased at high altitudes on account of the lesser atmospheric pressure. Deep-well pumps are superior to pitcher pumps in that they are less liable to freezing, need little or no priming, and can be used in deeper wells by lowering the working cylinder.

Sometimes a displacement pump is installed in the house or barn at some distance from the well, as shown in figure 13. The suction limit (vertical distance between working cylinder and water level) is reduced to some extent when the horizontal distance between well and pump is increased. In this report installations of this kind are called "house pumps." Some have a pitcher pump with the working cylinder on the first floor, and some have a deep-well pump with the working cylinder in the cellar and the pump-handle standard on the first or even the second floor.

Chain pumps are used in many wells in Connecticut and are of two varieties—rubber-bucket pumps and metal-bucket pumps. A rubber-bucket pump is a displacement pump of special type and consists

of a long tube, generally of wood, through which is passed an endless chain that has thick rubber washers on special links inserted at intervals of 6 to 10 feet. At the top the tube is fastened to a curbing, across the top of which is an axle with a crank and sprocket wheel to carry the chain. When the crank is turned the chain is drawn up through the tube and the rubber washers act as pistons and raise water which is discharged through an opening in the tube near the top.

Metal-bucket pumps are similar to rubber-bucket pumps in external appearance, but their principle is quite different. A chain, made of alternating plain flat links and special flat links that are fitted with small metal buckets, passes over a sprocket wheel turned by a crank. The buckets are about 2 inches square and 4 inches deep, and each has a lip so constructed that as it passes over the wheel it empties into a hopper-like spout the water it has carried up from below.

All these pumps are sanitary when the curbing and platform are tight enough to prevent waste water, surface drainage, and solid foreign matter from entering the well.

On a few farms where garden truck is raised the high commercial value of the crops, especially if they are forced for early markets, makes the pumping of water for irrigation profitable. Wells of large diameter are dug, but as the sanitary quality of the water is relatively unimportant they need not be covered or very carefully walled up. If the water table is high and the yield of the well large, as on some of the stratified-drift plains of the Southington-Granby area, centrifugal pumps driven by gasoline engines have been found to be well suited to the conditions. Inside a closed casing is a fan-like wheel, which is rotated at high speed and gives the water enough centrifugal inertia to force it out through a tangential discharge pipe. A partial vacuum is produced at the center of the pump and the water rushes in through a central opening. These pumps have to be primed, but they are only slightly affected by grit in the water. If properly designed and of the right size for the task given them they are very efficient.

SIPHON AND GRAVITY RIGS.

Dug wells that are situated higher than the points at which the water is to be used may be developed by means of a siphon pipe line provided the water level is not more than 25 feet below the ground and is above the point of delivery. Figure 14 illustrates such an installation. In some wells where the water level is very near the surface and where no hill intervenes between the well and the point of delivery and in many springs a direct gravity system may be used, obviating the necessity of occasionally priming the siphon. The gravity and siphon rigs are highly sanitary provided the surroundings

of the well or spring are safeguarded. If lead pipe is used care should be taken not to use any water that has stood a long time in the pipe. In some places where the fall from the well is not great enough to carry the water to the first floor of the house the water runs continuously to a cistern in the cellar and is pumped up by hand. The overflow of siphon and gravity systems is in many places used for watering troughs.

RAMS.

Wells and springs of large yield that lie lower than the point of utilization may be developed by rams. The hydraulic ram is a mechanical device that uses the momentum of a relatively large volume of water falling a short distance to raise a small volume to a relatively great height. Theoretically 100 gallons falling 10 feet would have enough energy to raise 10 gallons 100 feet or 1 gallon 1,000 feet, and other quantities and distances in proportion. However, on account of leakage through the valves and elasticity and friction in the pipes this condition is not realized. According to tables given by Björling,[19] when the ratio of lift to fall is 4 to 1, the ram will lift 86 per cent of the theoretical amount; with a ratio of 10 to 1, 53 per cent; with a ratio of 15 to 1, 17 per cent; and with a ratio of 25 to 1, only 2 per cent. Björling says further that the length of the drive pipe should be five to ten times as great as the fall. The delivery pipe (from the ram to the storage tank) should have an area of cross section from one-fourth to one-third as large as that of the supply or drive pipe (from the spring or well to the ram). The rapidity of the beat should be as great as is compatible with perfect and complete action of the valves and in most rams may be regulated by adjusting springs or weights on the main valve. Rams are open to the objection that they are noisy. The noise is transmitted along iron pipes but may be reduced or eliminated by the use of lead pipe or of a section of rubber hose.

Many people have been disappointed in trying to use rams because they did not realize their limitations. Rams must of necessity waste a large portion of the water. Before installing a ram careful measurement should be made of the flow of the well or spring during its lowest season, the amount of fall available, the amount of lift desired, and the horizontal distance from well to ram. If these data are supplied to the makers they will be able to recommend the best model and size of ram. With proper conditions a suitable ram properly installed will furnish a reliable, inexpensive, and permanent supply. It is customary to have the water from the ram delivered to a reservoir or tank in an elevated position, from which it is distributed by gravity.

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[19] Björling, P. R., Water or hydraulic motors, pp. 264–271, 1894.

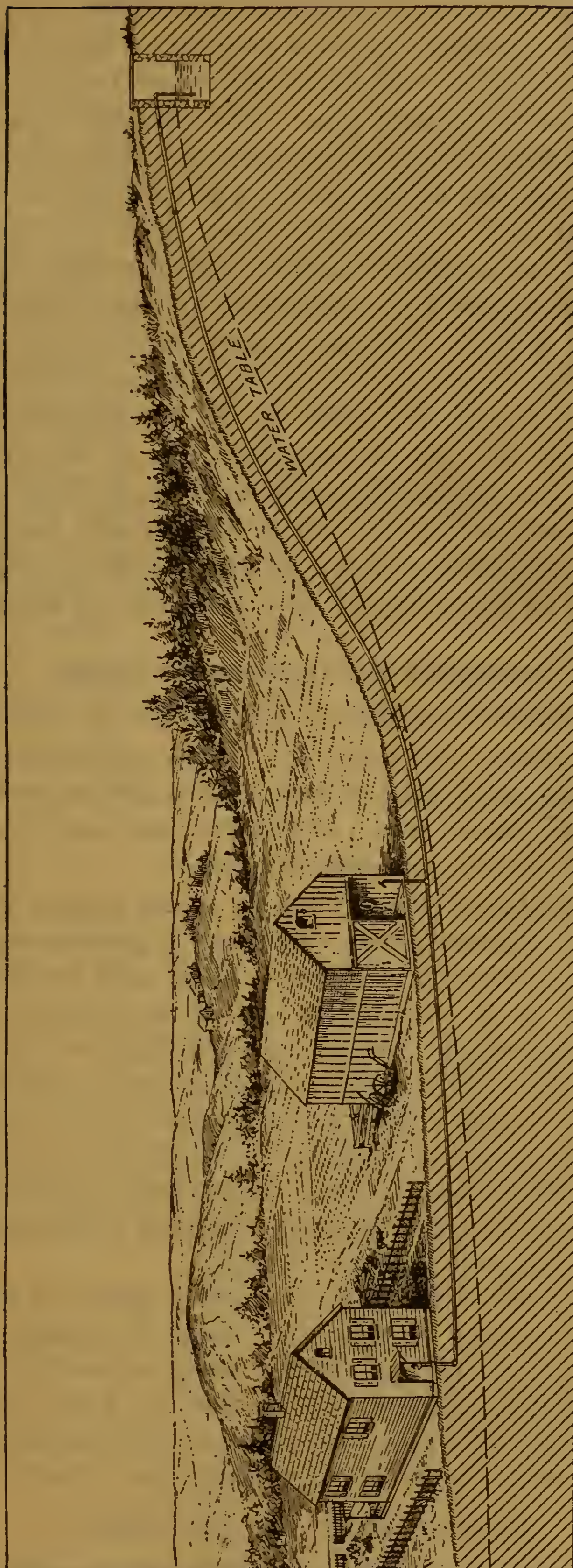

FIGURE 14.—Diagram showing siphon well and domestic waterworks.

Mr. H. S. Parmelee, of Granby, owns and operates a unique ram. It is installed at the crest of a siphon and differs from the ordinary ram only in that the waste valve is inclosed in order to prevent loss of suction. The chest in which the valves are built is virtually only an enlargement of the siphon pipe. The ram has been in operation over 20 years and has required only trifling outlays for repairs. The well is 7.7 feet deep and at the time it was visited (Oct. 25, 1915,) had 1.2 feet of water in it. The water, then, stands 6.5 feet below the ram, which is at the mouth of the well, and the waste pipe or long leg of the siphon discharges 10.5 feet below, so that there is an effective working head of 4 feet. The ram drives the water to a tank on the second floor of the house, 15 feet above the mouth of the well. This type of ram was patented in 1856 by E. W. Ellsworth (patent No. 16176) but seems not to be manufactured at present. It is eminently suited to raising small quantities of water from a shallow well that is situated where it is difficult to dig a trench for a gravity supply sloping to an ordinary ram. It also has the advantage that it can be operated on a very small flow, because the working parts are small and light.

WINDMILLS AND AIR-PRESSURE TANKS.

A popular method of supplying water is by the use of a windmill, pumping jack, pump, and reservoir. Many modifications are used; the windmill may be of steel or wood, on a steel or wood tower; the reservoir may be of steel, wood, or concrete and may be on the tower, on a near-by hill, or in a separate building.

Another equipment which is used by many people is the air-pressure system. A cylinder pump driven by a gasoline engine or electric motor pumps water into a closed steel tank containing air. As the water comes in it compresses the air and gives pressure sufficient to drive the water through the plumbing of the house. The pump is fitted with a snifting valve which takes in a little air with each stroke to replace that dissolved and absorbed by the water. Some of the tanks are equipped with telltales which give a signal or automatically start the motor when the water level is reduced below a set limit. It is the usual practice to put the tank in the cellar, but some are in specially constructed pits outside.

When tanks or reservoirs are built in the open it is found that the water is apt to become disagreeably warm in summer and to give trouble by freezing in winter. If the water is used for irrigation the heating in summer is an advantage in that the warm water gives less shock to the plants on which it is put, and no trouble is experienced in winter as the tanks are then drained and not in use.

PUMPING TESTS ON DUG WELLS.

One of the most important questions relative to the development of ground water is that of the available amount. Studies were made of two dug wells in the Southington-Granby area—one in till and

one in red sandstone—and indicated a very low rate of supply but yet sufficient for ordinary domestic needs. A study of a well in East Granby in stratified drift is cited for purposes of comparison.

On July 3, 1915, a test was made of Mr. Edwin L. Upson's well, in the town of Southington, shown on the map (Pl. III) as No. 97. The well is 22.3 feet deep and at the time had 5.4 feet of water in it. The lower 9 feet is blasted out of red sandstone, from cracks in which the water enters the well. The well has an average diameter of about 4 feet 2 inches. The equipment consists of a two-bucket rig at the well and an air-pressure system. A gasoline engine in a pit back of the house drives a double-acting cylinder pump (3-inch bore, 3½-inch stroke), which forces water and air into a cylindrical tank (3 feet in diameter, 8 feet in length) in the cellar. The pump was run from 10.25 to 11.25 a. m., and about 270 gallons was pumped into the tank. The depth from a datum point on the well curb was measured at 10-minute intervals during pumping in order to determine the rate of lowering. Then measurements were made at 15-minute intervals up to 4.05 p. m. to get the rate of inflow. Mr. Upson kindly made observations at greater intervals until the water had regained its original level. It took the well about 70 hours to refill. The following table gives the data:

Depths to water level in E. L. Upson's well, Southington, during pumping test.

Date.	Time.	Depth (feet).	Remarks.
July 3	10.25 a. m.	19.58	Pumping commenced.
	10.35	20.00	
	10.45	20.56	
	10.55	21.02	
	11.05	21.33	
	11.17	21.70	
	11.25	21.96	Pumping ceased.
	11.40	21.93	
	11.55	21.91	
	12.15 p.m.	21.87	
	12.25	21.85	
	12.50	21.82	
	1.06	21.79	
	1.20	21.77	
	1.35	21.74	
	1.50	21.72	
	2.05	21.69	
	2.20	21.67	
	2.35	21.65	
	2.50	21.63	
	3.05	21.61	
	3.20	21.58	
	3.35	21.56	
	3.50	21.54	
	4.05	21.53	
	6.05	21.37	Observations from this time on by Mr. Upson.
July 4	6.05 a. m.	20.62	
	9.05	20.57	
	12.05 p. m.	20.42	
	3.05	20.30	
	6.05	20.22	
July 5	6.05 a. m.	19.93	
	9.05	19.90	
	12.05 p. m.	19.84	
	6.05	19.70	
July 6	5.30 a. m.	19.58	

The figures in the table are also graphically expressed in figure 15. The irregularities in the curve for the forenoons of July 4 and 5 represent depressions of the water level by drawing water for house use. The rate of inflow was calculated for the first 6½ hours and for each succeeding 12-hour period.

Rate of inflow and corresponding average depression of the water table in E. L. Upson's well, Southington, during pumping test.

Period.	Depression of water level (feet).	Rate of inflow (gallons per hour).	Period.	Depression of water level (feet).	Rate of inflow (gallons per hour).
First	2.09	9	Fourth	0.49	2.5
Second	1.41	6.4	Fifth	.23	2
Third	.84	3.4	Sixth	.06	1

The data in this table are also graphically expressed in the inserted diagram in figure 15.

The following conclusions may be drawn. The draft of 270 gallons was replenished in about three days, but if pumping were done at

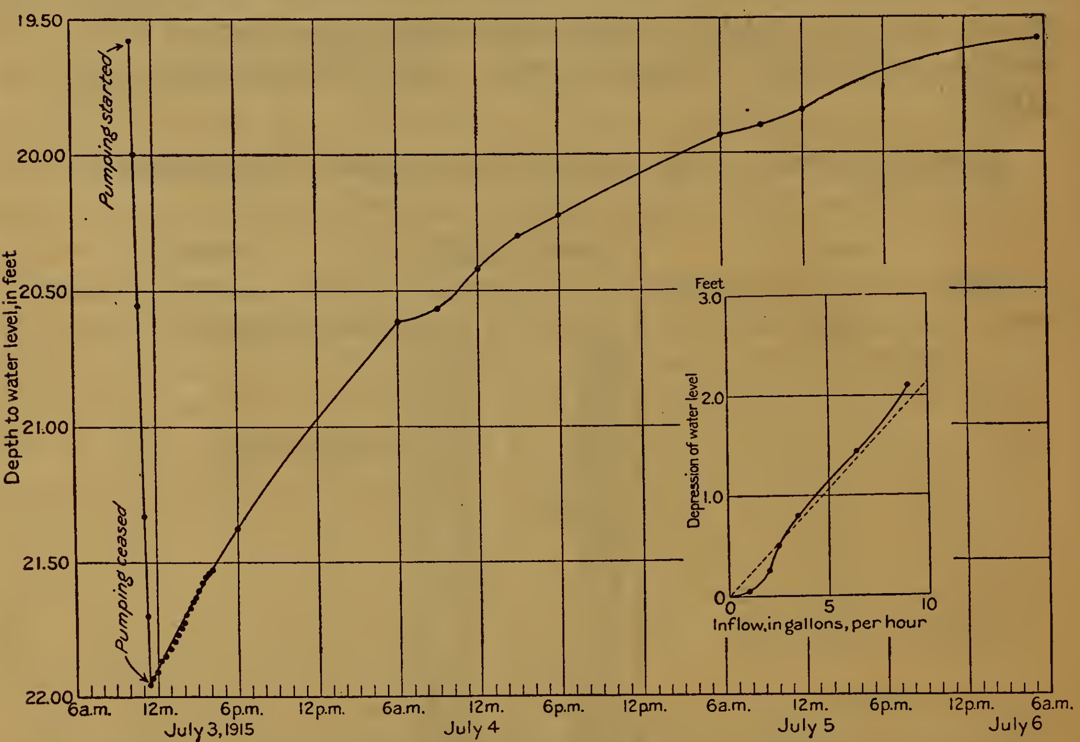

FIGURE 15.—Diagram showing recovery of E. L. Upson's well, Southington, after pumping, and relation of inflow to drawdown.

frequent intervals more water could be taken. If the periods of pumping were only six hours apart there would be 54 gallons available each time, for there would have intervened six hours with an average inflow of 9 gallons an hour. This is equivalent to 216 gallons a day. Under actual conditions of operation about 90 gallons a day is available, which seems to satisfy the demands on the well.

On June 2, 1915, a pumping test was made of Mr. H. W. Cleveland's dug well, at the northwest corner of the green in Plymouth village, to ascertain its rate of inflow. The well is No. 12 on the map (Pl. III). It is dug on a gently sloping hillside in a rather sandy till with an average amount of boulders and is in every sense a typical till well. The well is 24 feet deep and before pumping had 8.8 feet of water in it. The diameter is about 3 feet 3 inches. There is an air-pressure tank in the cellar with a cylinder pump driven by a ½-horsepower gasoline engine. The depth to the water was measured from a convenient datum on the well curb. In 1½ hours of pumping the water was lowered 4.06 feet, which represents a pumpage of about 34 cubic feet, or 250 gallons. After pumping ceased the depth to water was measured at intervals of 15 minutes. In 2¾ hours the level had risen 0.59 foot, which is equivalent to an inflow of about 5 cubic feet, or 37 gallons. This is at the rate of 13.3 gallons an hour for the whole well or 0.35 gallon an hour per square foot of seepage surface.

The following table gives the depth to water at intervals during the pumping of the well and during the first 2¾ hours of recovery:

Record of pumping test on H. W. Cleveland's well, Plymouth.

Time (p. m).	Depth from datum (feet).	Remarks.
1.20	15.59	Pumping commenced.
1.40	16.17	
2.00	17.32	
2.13	17.92	Pumping ceased a few minutes.
2.25	18.43	
2.40	19.19	
2.50	19.65	Pumping ceased.
3.05	19.59	
3.20	19.54	
3.35	19.48	
3.50	19.42	
4.05	19.38	
4.20	19.32	
4.35	19.26	
4.50	19.20	
5.05	19.15	
5.20	19.10	
5.35	19.06	

Figure 16 is a graphic representation of the data in the table. If the rate of recovery were constant, regardless of the amount of depression, and if it should proceed as rapidly as is indicated by the above figures, it would take about 19 hours for the well to fill to its original level. However, as the well fills there is less and less area from which seepage may take place, so the rate of inflow becomes slower and slower and the total time would be much longer. If the well were pumped to the capacity indicated by this test—that is, if 37 gallons was pumped every 2¾ hours—it could be made to yield

about 320 gallons every 24 hours. This well gives about one and a half times as much water as Mr. Upson's well but with a greater drawdown.

Tests made in 1916 on a dug well in stratified drift in Granby indicate a still greater yield.[20] This well was not observed during pumping, but after pumping ceased the water was observed to rise 1.53 feet in 41 minutes. As the well is about 4 feet in diameter, this is equivalent to an inflow of over 140 gallons. This well could be made to yield at least 210 gallons an hour, or 5,000 gallons a day.

Mr. Edward Wassong's dug well in till in the southeastern part of Southington also has a large yield. The well lies east of the house, on the talus slope of Meriden West Peak. The soil seems to be in part till and in part talus and must be a good aquifer, for the supply is abundant. The well is 29 feet deep and on April 14, 1915, had 13 feet of water in it. Its diameter is about 3 feet. A siphon carries the water to the house and to a creamery about 65 feet lower in elevation. The water runs continually into the cooling tank. The stream was of sufficient size at the time the well was visited to fill a 20-quart milk can in 1 minute and 57 seconds. This is equivalent to a little over 150 gallons an hour, or 3,600 gallons a day.

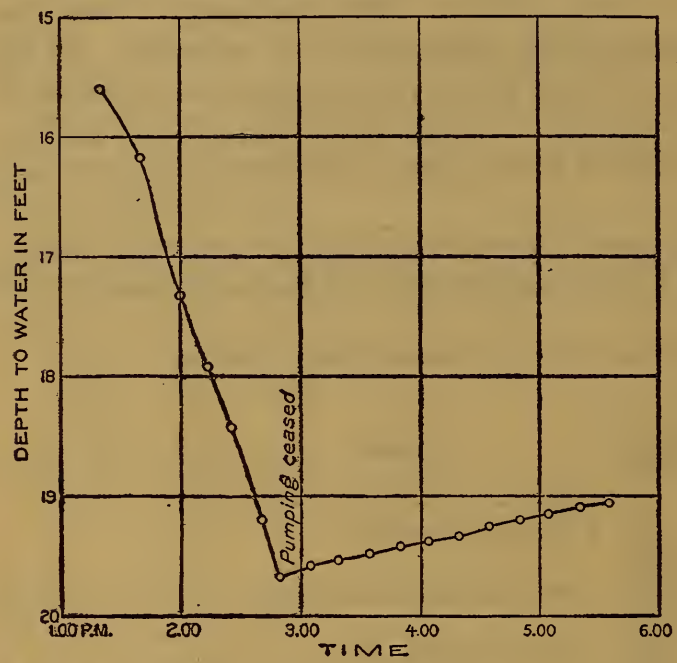

FIGURE 16.—Diagram showing recovery of H. W. Cleveland's well, Plymouth, after pumping.

INFILTRATION GALLERIES.

An infiltration gallery is a modification of a dug well and derives its water in a similar way. Turneaure and Russell[21] say of them:

> Where ground water can be reached at moderate depths it is sometimes intercepted by galleries constructed across the line of flow. * * * In form a gallery may consist of an open ditch which leads the water away, or it may be a closed conduit of masonry, wood, iron, or vitrified clay pipe, provided with numerous small openings to allow the entrance of water. * * * Galleries are usually constructed in an open trench. They are arranged to lead the water to the pump well and may be provided

[20] Palmer, H. S., Ground water in the Norwalk, Suffield, and Glastonbury areas, Conn.: U. S. Geol. Survey Water-Supply Paper 470, pp. 41–43, fig. 9, 1920.

[21] Turneaure, F. E., and Russell, H. L., Public water supplies, pp. 318–320, 1909.

with gates so that the water may be shut off from various sections. The cost of galleries is about the same as that of sewers in similar ground. It rapidly increases with the depth, but up to a depth of 20 or 25 feet it is sufficiently low so that the construction of galleries can often be advantageously undertaken. A gallery not only intercepts the water more completely than wells, but it replaces the suction pipe, it is more durable than either pipe or wells, and all trouble from pumping air is avoided.

Filter galleries may be so constructed that surface water is flooded over the ground alongside them and is collected in them after the removal of suspended matter as the water percolates through the soil.

DRIVEN WELLS.

Driven wells are made by driving a pipe into the ground by means of a maul or machine resembling a pile driver. The pipe is made up of enough sections to reach the ground-water level and may have either an open end or a closed end.

In closed-end driven wells a drive point slightly larger than the the pipe is used to penetrate the ground. Above the point is a perforated section covered with wire gauze which prevents sand from entering the well. As the pipe is driven down sections are screwed on to lengthen it. The pipes are usually from three-quarters of an inch to 3 inches in diameter, and the screens from 2 to 4 feet long.

Open-end driven wells are made by driving a plain pipe which may or may not have a heavy cutting shoe attached to it. The material inside the pipe is removed by means of a sand pump or a jet. In the jetting method water is forced down a small pipe inside the drive pipe and as it rises it carries up the sand, silt, and smaller pebbles. The pipe is perforated either before driving or by special tools after driving.

Either kind of driven well should be pumped very heavily for a while after driving in order to remove the fine silt and sand and to leave a screenlike layer of pebbles outside the perforated section.

Several kinds of pumps are used with driven wells. The most common practice is to screw a pitcher pump to the top of the pipe. In some of the larger driven wells a deep-well pump is put down inside the pipe, and in others a specially constructed section of the casing acts as the pump cylinder.

Driven wells are suited to loose sands and gravels in which caving would make trouble in digging wells. They are inexpensive and have the advantage that if they are unsuccessful the pipe may be withdrawn and used at another place. One disadvantage of driven wells is the proneness of the screen to become clogged by an incrustation of mineral matter or by silt and sand, and another is that fine particles may be drawn up with the water and score the working parts of the pump so that it works poorly.

DRILLED WELLS.

Drilled wells are in general deeper than dug or driven wells, and obtain their water from cracks and fissures in bedrock. They are made either by a percussion machine or by an abrasion machine. A percussion drill or churn drill has a long steel bar with a hardened and sharpened bit at the lower end. This is worked up and down by an engine and pounds its way through the rock. At intervals the drill is withdrawn and the débris is removed by means of a sand pump. Abrasion machines are built to revolve a hollow steel cylinder shod with chilled-steel shot or with diamonds. The rotation of the shot cuts a circular channel surrounding a core, which is broken into short sections and removed from the hole. It is necessary in general to put an iron or steel casing in the part of the drill hole above bedrock. Drilled wells in Connecticut range in diameter from 4 to 12 inches.

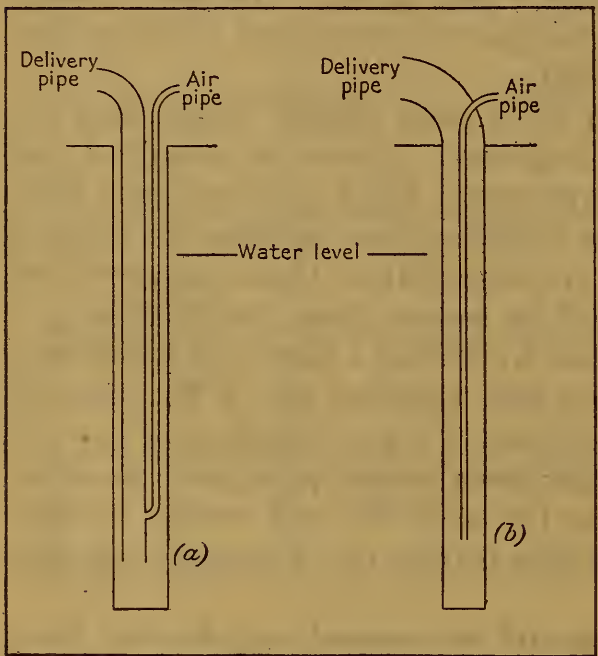

FIGURE 17.—Diagrams showing two types of air lift.

Where only moderate amounts of water are needed a pump of the deep-well type operated by hand or by power is used. In some wells where large amounts of water are to be raised from a great depth use is made of an air lift. Compressed air is forced down an air pipe and delivered near the bottom of a discharge pipe and then expands and rises, bringing water with it. The delivery pipe may be hung inside the well with the air pipe alongside it, as in *a*, figure 17, or the rock wall of the well and the casing may act as the delivery pipe, as shown in *b*. Each manufacturer puts out special designs of air nozzles that are claimed to be particularly effective, but all seem to work about equally well. It is essential that the length of the submerged portion of the air pipe should be from 30 to 70 per cent of the distance from the bottom of the air pipe to the point of discharge. In shallow wells the percentage of submergence must be greater than in deeper wells. The pressure used ranges from 20 to 100 pounds to the square inch and is often calculated at one-half to one-fourth pound for each foot of lift. The two great advantages of the

air lift are that it has no moving parts in the well, where they would be rather inaccessible in case of wear by grit in the water, and that it may be controlled and operated from a distant air-compressing station.

The success or failure of drilled wells can not be predicted, because of the irregular distribution of the fissures, but it is probable that at any point a satisfactory water supply will be obtained. Among the 237 drilled wells in crystalline rocks studied by Ellis [22] only 3, or 1.24 per cent, are recorded as obtaining no water. A supply of 2 gallons a minute is considered abundant for domestic needs, though insufficient for certain purposes such as manufacturing. Among the 134 wells drilled in crystalline rocks whose yield Ellis ascertained, only 17, or about 12.5 per cent, furnish less than 2 gallons a minute. It is probably a moderate estimate to state that not less than 90 per cent of the wells sunk in the crystalline rocks have given supplies sufficient for the use required. Wells may be unsuccessful not only as regards the quantity of the supply but also as regards the quality. The quality of the waters from the drilled wells in the Southington-Granby area is in general good, but near the sea these wells are likely to yield brackish or salt water.

Although wells are reported by Ellis that obtain water at all depths from 15 to 800 feet, the largest percentage of failures is in wells over 400 feet deep. This is due to the smaller number and greater tightness of joints at considerable depths. From a consideration of the greater cost per foot of drilling at depth and of the lesser probabilities of success it is concluded that "if a well has penetrated 250 feet of rock without success the best policy is to abandon it and sink in another locality."

Gregory,[23] speaking of wells drilled in sandstone, says that "of the 194 wells recorded * * * only 11, or 5.6 per cent, failed to obtain 2 gallons a minute, the minimum amount desired for domestic purposes." The average yield of 112 of these wells is "27½ gallons a minute, the largest being 350 gallons and the smallest two-thirds of a gallon." In view of the decreasing abundance in which fissures are found as depth increases and of the greater cost of deep drilling it is considered "good practice to abandon a well that has not obtained satisfactory supplies at 250 to 300 feet."

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[22] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 91, 1909.

[23] Idem, p. 130.

Statistics of drilled wells in various kinds of rocks in the Southington-Granby area.

Kind of rock.	Average yield.		Average depth.					
	Gallons per minute.	Number of records.	Total.		To rock.		To water.	
			Feet.	Number of records.	Feet.	Number of records.	Feet.	Number of records.
Stratified drift	12.5	2	61.4	9			19.7	3
Sandstone	24.1	37	134.5	68	29.6	57	25.9	28
Trap	2	1	127.6	5	39.6	4		
Crystalline rocks	11.3	18	145.8	24	27.8	22	20.0	11
	19.6	58	129.6	106	30.5	85	23.9	42

Kind of rock.	Number of wells yielding, in gallons per minute—						Total number of wells.	Average yield (gallons per minute).
	0–5	6–15	16–25	26–50	51–100	Over 100		
Stratified drift	0	2	0	0	0	0	2	12½
Sandstone	13	8	6	6	2	2	37	24
Trap	1	0	0	0	0	0	1	2
Crystalline rocks	10	5	1	1	1	0	18	11⅓
	24	15	7	7	3	2	58	19

No measurements of the yield of drilled wells were made by the writer, but many of the owners were able to give the figures determined by the drillers. The yield of drilled wells at some manufacturing plants is rather accurately known.

SPRINGS.

In developing a spring as a source of water supply it is advisable to make some sort of a substantial collecting basin. No material which may rot should be used. Rotting works in two ways to injure a spring supply—it adds objectionable decayed organic matter, and it weakens the walls so as to allow the entrance of surface water which may be polluted by persons or animals that come to the spring. No spring should be so arranged that water must be dipped from it, as this process allows the transfer of pollution from the hands. The reservoir should be covered and a pipe provided to carry off the flow, as this method not only prevents pollution from the hands but also prevents treading and pollution by cattle around the spring. If the spring is used for watering stock a pipe and trough should be provided.

In order that the water may enter the reservoir readily its bottom should be thoroughly perforated or it should have no bottom, but it should have stout, water-tight walls extending a foot or two above and below the ground level to prevent the entrance of surface wash. Where it is desirable to use the full yield of the spring, the shape of the springy area determines the shape of the reservoir. The springs

of the Satan's Kingdom Spring Water Co., in New Hartford (No. 61, Pl. III), are in a line running along at a uniform level on a steep slope. A trench about 25 feet long, 6 feet wide, and 3 feet deep was dug, and walls of concrete 1 foot thick and 4 feet high were built in it to form a collecting gallery. Sides and roof of frame construction were put on to keep out foreign matter. The shape allows nearly complete recovery of the water. If only a moderate supply is needed the reservoir may be of any convenient shape. Small springs may be developed by setting a length of large pipe of concrete, iron, or vitrified tile vertically in the ground. Such tile is superior to a wooden cask or box because of its greater durability and lesser expense in the long run. Whatever the type of the reservoir, it should be provided with a cover or roof that will effectually keep out leaves, sticks, wind-blown dirt, and small animals.

It was possible to make rough measurements of the yield of a number of springs well distributed throughout the Southington-Granby area. Some were measured by observing the time necessary to fill a vessel of known capacity, and the overflow streams of some could be measured by means of floats. The yield of two or three large springs whose water is bottled and sold was learned from the owners.

In the following table spring No. 30 in Bristol and spring No. 61 in New Hartford are groups of springs rather than individual springs. The remaining 32 springs have an average yield of nearly 7 gallons a minute and range from a quarter of a gallon to 40 gallons.

Yields of springs in Southington-Granby area.

Town.	No. on Pl. III.	Yield (gallons per minute).	Town.	No. on Pl. III.	Yield (gallons per minute).
Avon	22	2	Hartland	13	3.33
Do	46	2	Harwinton	42	.25
Do	59	.5	Do	67	30
Barkhamsted	11	1	Do	125	2
Bristol	30	100	New Hartford	59	1.5
Do	87	20	Do	61	250
Do	121	15	Plymouth	9	2
Burlington	15	2.5	Prospect	4	1
Do	26	5	Do	6	4
Do	36	6	Do	36	6
Canton	17	.5	Do	52	3.5
Do	26	.75	Simsbury	35	10
Do	84	40	Southington	48	12.5
Cheshire	9	1	Do	52	2
Do	82	1	Do	59	10
Do	107	2.5	Do	79	1
Granby	3	30	Wolcott	52	1

GROUND WATER FOR PUBLIC SUPPLY.

Most of the public supplies for cities and villages in New England are obtained by impounding streams, but a few come from wells or infiltration galleries. Supplies could be developed for many of the villages and smaller cities from bodies of stratified drift.

Most ground-water systems for public supply comprise one or more batteries of driven wells, connected by suction mains to pumping plants which discharge into small reservoirs. A few plants, however, use dug wells or infiltration galleries. Geologic conditions in New England do not afford adequate artesian supplies, as in some other parts of the country. The driven wells are similar to those described under "Recovery of ground water" (p. 51), except that they are generally greater in diameter than domestic wells. They are so located that they will draw from as great an area as possible with the least amount of piping in consideration of the difference in the abundance of the supply throughout the field. If the direction of the underflow is known the lines of wells are placed at right angles to it in order that the maximum yield may be intercepted without interference among the wells.

In selecting a suitable place for a battery of wells it is more important to consider its topography and the character of the soil than to consider convenience in geographic situation or the apparent wetness of the soil. Sandy or gravelly plains of stratified drift or alluvium, especially those near lakes or streams, are promising places even though the surface may be rather dry. Wet grounds as a rule indicate the presence underground of an impervious layer that would prevent a large flow of water to driven wells. Glacial outwash plains and the flood plains of rivers should be thoroughly studied. Several tests wells should be sunk and should be vigorously pumped in order to determine the water-bearing capacity of the soil at different points and depths. The pumping should be as heavy and as long continued as practicable, in order that any deterioration in the quality or decrease in the quantity of the water may be detected. Analyses of samples collected at intervals and measurements of the yield should be made. The static level in open wells near the test wells should be observed before, during, and after pumping tests for the purpose of ascertaining the amount and extent of drawdown of the water table and its rate of recovery.

The source of the water may be rainfall on an adjacent area or underflow from some body of water or both. Water from a body of surface water is greatly improved in quality by passing slowly through a great mass of soil. Water derived chiefly from the absorption of rainfall by the soil has a temperature of 48° to 52° F., which is the general temperature of the earth below the depth of diurnal variation. Surface waters are much warmer in summer and colder in winter, so that a wide range of temperature in the driven-well water would indicate it to be of surface origin.

The experience at many plants at which ground water is pumped into open reservoirs is that there is likely to be a heavy growth of algae, even more than where surface waters are thus stored Roofing

the reservoirs is found to reduce or eliminate algal growths, for they thrive only in abundant light and air. Roofed reservoirs also keep the temperature more nearly uniform. As roofing is expensive, however, it is the usual practice to have much smaller storage for ground supplies than for surface supplies and to depend on the pumps to keep pace with the fluctuations in consumption.

An excessive amount of carbon dioxide, iron, or manganese in some supplies has been troublesome. Carbon dioxide gave a good deal of trouble at the plant at Lowell, Mass.,[24] for a time, and experiments were made to find a remedy. It was found that spraying the water under low pressure from small nozzles would aerate it and thus eliminate the gas. By another set of experiments, conducted at the same time, for the removal of iron and manganese, which had increased in amount as the draft on the supply became heavier, the conclusion was reached that "the iron and manganese can be successfully and economically removed by limited aeration, passage through a coke prefilter not less than 8 feet in depth, operated as a contact bed at a rate of 76.5 million gallons per acre daily, and subsequent filtration through sand at a rate of 10 million gallons per acre daily." The rate of filtration and the details of construction of the filter beds would be somewhat different with waters of different content of carbon dioxide, iron, and manganese.

One of the largest water supplies in New England derived from wells has been developed at Lowell, Mass. Lowell's first waterworks, built in 1870, comprised a filter gallery 1,300 feet long parallel to and 100 feet distant from Merrimack River, from which water was pumped to a distributing reservoir. The supply was about 900,000 gallons a day (1875), and as the daily consumption became greater a supplementary supply was pumped direct from the river and passed through a sand filter. An epidemic of typhoid fever in 1890 and 1891 necessitated a better supply. Test wells were driven at various places near the city, and finally a contract was awarded to the Cook Well Co. for a 5,000,000-gallon supply to be obtained by driven wells along River Meadow Brook. Forty-five 6-inch wells of the open-end type, 47 to 67 feet deep, were sunk by sand pumps and at first yielded 7,000,000 gallons a day but soon fell off to only 2,000,000 gallons. Fifteen 4-inch wells were added and increased the yield to 3,000,000 gallons, but the contractors considered it impossible to get 5,000,000 gallons and abandoned their contract. In 1894 the Hydraulic Construction Co. of New York sunk by the jetting method 120 open-end 2-inch wells a mile upstream from the old wells. As the total yield from both well fields was less than 5,000,000 gallons a day it was necessary to pump river water to

[24] Barbour, F. H., Improvement of the water supply of the city of Lowell, a special report to the municipal council, 1914.

supply 7,000,000 gallons a day in 1895. In 1895 B. F. Smith & Co. drove 169 successful wells 27 to 40 feet deep at a third locality 150 to 350 feet from Merrimack River. The daily yield from this area, known as the Lower Boulevard Field, was about 4,000,000 gallons.

Excessive corrosion of lead pipes in the city developed in 1899, and the State board of health attributed it to the high content of carbon dioxide in the water from the Cook wells. Consequently the Cook field and the field a mile upstream on River Meadow Brook were abandoned in 1900. Fifty-two wells driven in 1900 and 125 driven in 1901 supply the Upper Boulevard station. The system was adequate for the demand in 1902 and 1903, but the supply began to decrease, and from 1904 to 1911 it was found necessary to use the Cook wells. A deterioration in quality due to overdraft was coincident with the decrease in supply. In 1911 118 new wells were added in the Boulevard field, so that there were then 450 wells available in this area, exclusive of a few that had been abandoned. The addition of these wells counteracted the overdraft, and for several years the supply was satisfactory.

The wells that have been sunk since 1900 are of the closed-end type. They are lined with 2½-inch extra heavy iron pipe with a bottom section 38 inches long in which are bored 180 half-inch holes. A heavy brass wire wound spirally around the pipe separates it from a brass screen with vertical slots, 20 to the inch horizontally and 6 to the inch vertically. The bottom is screwed into a cast-iron driving point 4⅛ inches in diameter that protects the strainer from abrasion. The wells are driven with a heavy drop hammer. As the soil in which the wells are driven is fine grained the wells have to be cleaned at intervals. Each casing is capped at the surface, and a connection with the suction main is made below the cap through a T. In general the wells are staggered 12 feet apart on alternate sides of the suction main and 4 feet away from it.

That the water comes in large part from the river is shown by the seasonal range of temperature from 45° to 65° F., which is more pronounced than that of true ground water. The deterioration upon overdraft is presumably due to the fact that the water is then retained a shorter time in the soil and consequently loses less of its impurities.[28]

QUALITY OF GROUND WATER.

ANALYSES AND ASSAYS.

The chemical studies made in connection with this report comprise 50 assays and 31 analyses by S. C. Dinsmore, 4 analyses by Alfred A. Chambers, and 3 analyses made by other chemists and furnished by owners of wells and springs. The quantities are reported in parts per million. The results are given under the several towns.

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[28] Thomas, R. J., The Lowell waterworks and some recent improvements: New England Waterworks Assoc. Jour., vol. 27, March, 1913.

CONSTITUENTS DETERMINED BY ANALYSIS.

In the analyses by Mr. Dinsmore the following constituents were determined: Silica (SiO_2), iron (Fe), calcium (Ca), magnesium (Mg), carbonate radicle (CO_3), bicarbonate radicle (HCO_3), sulphate radicle (SO_4), chloride radicle (Cl), nitrate radicle (NO_3), and total dissolved solids. In the analyses by Mr. Chambers the same constituents and also sodium and potassium together (Na+K) were determined. In the assays the following constituents were determined: Iron (Fe), carbonate radicle (CO_3), bicarbonate radicle (HCO_3), sulphate radicle (SO_4), chloride radicle (Cl), and total hardness as $CaCO_3$.

VALUES COMPUTED.

In the analyses by Mr. Dinsmore the following quantities were computed: Sodium and potassium (Na+K), total hardness as $CaCO_3$, scale-forming ingredients, foaming ingredients, and the coefficient of corrosion. The computation of sodium and potassium was made by calculating the sum of the reacting values of the acid radicles (CO_3, HCO_3, SO_4, Cl, and NO_3) and subtracting from it the sum of the reacting values of calcium (Ca) and magnesium (Mg). The reacting value of a constituent is its capacity to enter into chemical combinations and is equal to the amount of it present multiplied by its valence and divided by its molecular weight. The excess of the acid radicles is considered to be chemically equivalent to the sodium and potassium. They are computed on the hypothesis that only sodium was present, by dividing the difference between the reacting values of the acids and bases by the reacting value of sodium. The result is reported as parts per million of sodium and potassium.

Total hardness was computed in the conventional terms of calcium carbonate by the following formula given by Dole:[30]

$$H = 2.5\ Ca + 4.1\ Mg$$

The computations of the scale-forming constituents, and the foaming constituents, and of the coefficient upon which the probability of corrosion is based, were made according to the following formulas by Dole:[31]

$$\text{Scale-forming constituents} = Sm + Cm + 2.95\ Ca + 1.66\ Mg.$$
$$\text{Foaming constituents} = 2.7\ Na.$$
$$\text{Coefficient of corrosion} = 0.0821\ Mg - 0.0333\ CO_3 - 0.0164\ HCO_3.$$

The symbols Sm and Cm represent the suspended matter and colloidal matter in parts per million.

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[30] Mendenhall, W. C., Dole, R. B., and Stabler, Herman, Ground water in San Joaquin Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 398, p. 45, 1916.

[31] Idem, p. 65.

In the assays the same values were computed, except the total hardness, which was determined; and in addition the values of total solids were computed. The following formula by Dole[32] was used to compute the sodium (Na) equivalent to the sodium and potassium taken together:

$$Na = 0.83\ CO_3 + 0.41\ HCO_3 + 0.71\ Cl + 0.52\ SO_4 - 0.5\ H$$

The symbols represent the parts per million of computed sodium and of carbonate, bicarbonate, chloride, sulphate, and total hardness found by the assay.

The total solids were computed by the following approximate formula of Dole:[33]

$$T.\ S. = SiO_2 + 1.73\ CO_3 + 0.86\ HCO_3 + 1.48\ SO_4 + 1.62\ Cl$$

The symbols represent the parts per million of silica and the carbonate, bicarbonate, sulphate, and chloride radicles. In applying this formula to the assays it was necessary to set some arbitrary value for silica. Inasmuch as the average silica content in the analyses of ground waters from the Southington-Granby area was 13 parts per million, 15 parts per million was taken as the arbitrary value for silica. The estimate of solids is rough and is reported to the nearest 10 if above 100 parts per million and to the nearest 5 if below 100.

The value representing scale-forming constituents was computed according to an approximate formula by Dole:[34]

$$\text{Scale-forming constituents} = Cm + H$$

The symbols represent the parts per million of colloidal matter and of total hardness in terms of $CaCO_3$. Inasmuch as the colloidal matter is essentially the same as the sum of silica and iron, the equation has been used in the equivalent form

$$\text{Scale-forming constituents} = SiO_2 + Fe + H$$

The value of silica was taken arbitrarily as 15 parts per million, as in the computation of total solids. The ratio between calcium and magnesium is an unknown and variable one and introduces a further error. The results are reported to the nearest 10 if above 100, and to the nearest 5 if below 100.

The same formula was used for computing foaming ingredients in the assays as in the analyses.

[32] Mendenhall, W. C., Dole, R. B., and Stabler, Herman, Ground water in San Joaquin Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 398, p. 57, 1916.

[33] Idem, p. 81.

[34] Idem, p. 66.

ACCURACY OF ANALYSES AND ASSAYS.

The analyses in this report were all made substantially according to the methods outlined by Dole,[35] who gives also a discussion of accuracy of methods and results based on both theoretical and practical considerations. Assays were made as described by Leighton,[35a] except for the use of solutions instead of solid reagents. The results obtained in assays are not all as accurate as the corresponding values obtained in analyses, but it has been shown [36] that the classification of a water for domestic or boiler use or for irrigation is nearly always the same, whether based on an analysis or an assay.

CHEMICAL CHARACTER OF WATER.

The statement in the analytical tables under the heading "Chemical character" shows the predominating basic and acid radicles. Bicarbonate, HCO_3, does not appear because for this classification it has been united with the carbonate and the two reported together as CO_3.

INTERPRETATION OF ANALYSES AND ASSAYS.

In addition to the chemical interpretation discussed in the preceding section, the analyses and assays have been interpreted as regards their suitability for boiler and domestic use.

WATER FOR BOILER USE.

Three kinds of trouble in boilers—the formation of scale, foaming, and corrosion—are due to the nature and quality of the salts in solution in the water. Scale formation is due to the deposition of mineral matter within the boiler as a result of heating under pressure and of evaporation. These deposits increase the fuel consumption, as they are bad conductors of heat, and they also decrease the capacity of the boiler. They are a source of expense and a potential cause of explosions. Scale is formed of the substances in the feed water that are insoluble or become so under the usual conditions of boiler operation. It includes all the suspended matter, the silica, iron, aluminum, calcium (principally as carbonate and sulphate), and magnesium (principally as oxide but also as carbonate).

Foaming is the formation of bubbles upon and above the surface of the water, and it is intimately connected with priming, which is the passage of water mixed with steam from the boiler. Foaming is believed to be due principally to sodium and potassium which remain

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[35] Dole, R. B., The quality of surface waters in the United States, Part I: U. S. Geol. Survey Water-Supply Paper 236, pp. 9–23, 28–39, 1909.

[35a] Leighton, M. O., Field assay of water: U. S. Geol. Survey Water-Supply Paper 151, 1905.

[36] Mendenhall, W. C., and others, Ground water in San Joaquin Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 398, pp. 43–50, 1916.

in solution after most of the other bases are precipitated as scale and which increase the surface tension of the water. The increased surface tension tends to prevent the steam bubbles from bursting and escaping. Other factors undoubtedly affect or cause foaming, but sodium and potassium are the chief causes. The principal ill effects of foaming are that the water carried over may injure the engine and that it may cause violent and dangerous boiling. Where waters that foam badly are used it is necessary to "blow off" the water at frequent intervals.

Corrosion, or "pitting," is caused chiefly by the solvent action of acids on the boiler iron. Many acids have this effect, but the chief ones are those freed by the deposition of hydrates of iron, aluminum, and especially of magnesium. The acid radicles that were in equilibrium with these substances may pass into equilibrium with other bases, thus setting free equivalent quantities of CO_3 and HCO_3; or they may decompose carbonates and bicarbonates that have been deposited as scale; or they may combine with the iron of the boiler shell, thus causing corrosion; or they may do all three of these things. Even with the most complete analysis this action can be predicted only as a probability. If the acid thus freed exceeds the amount required to decompose the carbonates and bicarbonates it corrodes the iron. The danger from corrosion obviously lies in the weakening of the boiler, which may result in explosion.

The formula for the corrosive tendency [37] used in computations based on the analyses expresses the relation between the reacting values of magnesium and the radicles involving carbonic acid. If the coefficient of corrosion (c) is positive the water is corrosive. If $c + 0.0499$ Ca (the reacting value of calcium) is negative the mineral constituents will not cause corrosion. If $c + 0.0499$ Ca is positive corrosion is uncertain. These three conditions are indicated by the symbols C, N, and (?), respectively.

In working with the assays it is necessary to restate these conditions, as the amounts of magnesium and calcium are unknown. One-fiftieth of the total hardness is equivalent to the reacting value of calcium and magnesium, and H divided by 230 (0.004 H) is equivalent to the reacting value of magnesium on the assumption that Ca = 6 Mg, a ratio in which magnesium is given its smallest probable value in relation to calcium. The reacting values of carbonate and bicarbonate are represented, respectively, by 0.033 CO_3 and 0.016 HCO_3, the coefficients being the ratio of the valence of each radicle to its molecular weight. The following propositions result:

If $0.033\ CO_3 + 0.016\ HCO_3 \geqq 0.02$ H, then the water will not cause corrosion.

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[37] Mendenhall, W. C., and others, op. cit., p. 66.

If $0.033\ CO_3 + 0.016\ HCO_3 < 0.004\ H$, then the water is corrosive.

If $0.033\ CO_3 + 0.016\ HCO_3 < 0.02\ H$ but $> 0.004\ H$, then corrosion is uncertain.

Scale formation, foaming, and corrosion are the principal criteria in rating waters for boiler use, but their evaluation is a matter of personal experience and judgment. The committee on water service of the American Railway Engineering and Maintenance of Way Association has offered two classifications by which waters in their raw state may be approximately rated, but, as its report states, "It is difficult to define by analysis sharply the lines between good and bad water for steam-making purposes." The committee's table, which is given below with the amounts changed to parts per million, was used in rating the waters for this report. In every case the less favorable of the two ratings was given.

Ratings of water for boiler use according to proportions of incrusting and corroding constituents and according to foaming constituents.

Incrusting and corroding constituents.			Foaming constituents.		
Parts per million.		Classification.[a]	Parts per million.		Classification.[b]
More than—	Not more than—		More than—	Not more than—	
....	90	Good.	....	150	Good.
90	200	Fair.	150	250	Fair.
200	430	Poor.	250	400	Bad.
430	....	Bad.	400	....	Very bad.

[a] Am. Ry. Eng. and Maintenance of Way Assoc. Proc., vol. 5, p. 595, 1904.
[b] Idem, vol. 9, p. 134, 1908.

WATER FOR DOMESTIC USE.

Waters which do not exceed 200 parts per million hardness and which are sufficiently low in mineral matter to be palatable are satisfactory for drinking and cooking. Although waters high in hardening constituents can be used for drinking purposes they are unsatisfactory for cooking and laundering. Hardness exceeding 1,500 parts per million makes water undesirable for cooking and water much softer than that consumes excessive quantities of soap in washing. Approximately 200 parts per million of carbonate, 250 parts of chloride, and 300 parts of sulphate can be detected by taste. The amounts of these constituents which can be tolerated by a human being are considerably higher than the above, but waters exceeding 300 parts per million of carbonate, 1,500 parts of chloride, or 2,000 parts of sulphate are apparently intolerable to most people. It must be pointed out, however, that local conditions and individual preference largely determine the significance of the terms "good" or "bad" as applied to the mineral quality of water for domestic use.

CONTAMINATION.

Water supplies may become contaminated in various ways, chiefly by industrial and manufacturing wastes, by the washing in of surface water, or by sewage. Industrial wastes rarely pollute ground-water supplies, and sea water, which along coasts is a source of contamination, need not be considered in this report, because of its nonexistence in the Southington-Granby area. Sewage is a very serious danger and is of various sorts, including animal excreta, human excreta, and kitchen wastes. Wells should never be constructed where there is any possibility of underflow from barnyards, privies, or kitchen drains. No spring that is thus wrongly situated should be used. No barnyard, privy, or kitchen drain should be built where it might pollute a well or spring. No rule can be laid down as to the direction of flow of the ground water, but it is generally the same as the direction of slope of the surface of the ground.

In addition to making safe the location of a well or spring, precautions should be taken to prevent the entrance of surface wash. The ground around dug wells should be filled in enough to make rain water and drippings flow away from them and not back into them. An excellent construction is a concrete apron several feet wide on all sides, and sloping away from the well. Cattle should be kept away from wells and springs by a fence, and they should be watered at a trough some distance away. Drilled wells should have the iron casing set firmly into the bedrock to prevent entrance of shallow water, and the casing should extend at least a foot above ground to keep out surface wash.

TABULATIONS.

The results of the analyses and assays and the results of the computations based on them are tabulated by towns. Tables of analyses and assays comparing the waters from the various water-bearing formations are given on page 65. Within each table the data have been grouped according to the formation in which the waters occur, and the average amounts of each constituent are reported together with the number of analyses or assays used.

The group of analyses headed "schist" comprises only waters from schists, but the group of assays with the same heading includes one sample from gneiss and one from granite gneiss. The analysis of water from well No. 86, in Plymouth, was omitted, as it is abnormally high in chloride and in sodium and potassium. The analysis of water from well No. 69, in Harwinton, and the assay of water from well No. 14, in Hartland, were also omitted from the tables of averages because they are abnormally high in total solids and in almost every constituent.

A study of the table of averages of analyses shows that the schist waters are in general the best, and that the till and stratified-drift

waters are both of nearly as great excellence. The sandstone waters run comparatively high in iron, calcium, magnesium, bicarbonate radicle, total hardness, and scale-forming ingredients.

The table of averages of assays corroborates that of analyses, except that it indicates no great difference in quality between sandstone waters and stratified-drift waters. Although the former contain less total dissolved solids, constituents that are significant in economic interpretation are present in greater amounts than in the stratified-drift waters.

Averages of groups of analyses of waters from the water-bearing formations of the Southington-Granby area.

[Parts per million except as otherwise designated.]

Formation.	Silica (SiO_2).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium and potassium (Na+K).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chloride radicle (Cl).	Nitrate radicle (NO_3).	Total dissolved solids.	Total hardness as $CaCO_3$.	Scale-forming constituents.	Foaming constituents.	Number of analyses averaged.
Schist	14	0.51	7.9	2.2	6.0	0.0	30	5.1	4.8	4.5	62	29	42	16	4
Sandstone	14	.71	29	4.6	12	.0	77	21	8.9	18	144	90	104	32	5
Till	14	.17	12	3.3	5.2	.0	36	7.0	7.0	8.9	74	42	53	14	17
Stratified drift	13	.12	12	3.3	10	.0	41	8.9	9.6	12	87	44	55	27	10

Averages of groups of assays of waters from the water-bearing formations of the Southington-Granby area.

[Parts per million except as otherwise designated.]

Formation.	Iron (Fe).	Sodium and potassium (Na+K).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chloride radicle (Cl).	Total dissolved solids.	Total hardness as $CaCO_3$.	Scale-forming constituents.	Foaming constituents.	Number of assays averaged.
Schist	0.12	4	0	45	2	7	68	40	57	10	6
Sandstone	.09	9	0	82	4	9	105	65	79	27	7
Till	.20	11	0	52	4	13	86	42	57	30	21
Stratified drift	.05	24	0	84	6	15	121	48	63	66	14

TEMPERATURE OF GROUND WATER.

The temperature of ground water depends on and tends to become the same as that of the material through which it circulates. A layer a few inches thick at the top of the ground varies greatly in temperature every 24 hours, owing to the heating effect of the sun in the daytime and the radiation of heat at night. At a moderate depth these diurnal variations become negligible and only seasonal fluctuations of temperature occur. At a still greater depth there are not even seasonal fluctuations and the temperature is uniform the year around. The depth of this zone of no seasonal fluctuation is believed

to be 50 or 60 feet. Its temperature tends to be the same as the mean annual temperature of the locality, and this ranges from 46° at Cream Hill, in Cornwall, to 49.5° at New Haven.[38] In the Southington-Granby area it probably averages about 47° F. Springs whose waters have moved a considerable distance at such depth have this temperature the year around, but if the circulation has been in large part in the zone of seasonal fluctuation the water will be warmer in summer and colder in winter. It seems probable that springs on steep north slopes, where the heating effect of the sun is at a minimum, would be a little cooler than normal, and springs on south slopes, where the sun's effect is at a maximum, would be a little warmer. The actual temperature of the water is, perhaps, not so good a criterion for determining the depth at which water has circulated as the uniformity of temperature throughout the year. Most of the dug wells and springs in the area are supplied from moderate depths and show seasonal fluctuations of temperature. Below a depth of 50 or 60 feet the temperature increases, owing to the internal heat of the earth. The increase is about 1° F. for every 60 feet increase in depth, so that water from deep drilled wells is likely to be warmer than 47° F.

DETAILED DESCRIPTIONS OF TOWNS.

AVON.

AREA, POPULATION, AND INDUSTRIES.

Avon is in Hartford County, about 16 miles south of the Massachusetts boundary, and has an area of about 23 square miles, one-half of which is wooded. The town is bounded on the west by the southward reach of Farmington River between Collinsville and Unionville, and on the east by the crest of Talcott Mountain. In 1830 this area was taken from the town of Farmington and incorporated as a separate town under its present name. Its population in 1910 was 1,337. The following table shows that up to 1870 the population of the town fluctuated to a slight extent, but that since then it has increased steadily.

Population of Avon, 1830–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1830	1,025	1860	1,059	1890	1,182
1840	1,001	1870	987	1900	1,302
1850	995	1880	1,057	1910	1,337

[a] Connecticut Register and Manual, 1915, p. 652.

The population is centered at three points. The chief center is at Avon, in the northeast corner of the town, on the northward-flowing

[38] Summaries of climatological data by sections: U. S. Dept. Agr. Weather Bureau Bull. W, p. 2, sec. 105, p. 11, 1912.

reach of Farmington River and on the Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad. West Avon, near the center of the town, is a smaller village, and in the valley of Roaring Brook is a concentration of houses known locally as Lovely Street. There are about 50 miles of roads in the town, of which about 7 miles are metaled State trunk lines connecting with Hartford, Simsbury, Canton, and Collinsville. Most of the other roads are of excellent dirt construction, but some that cross the sandy parts of the town are poor. The principal industries are agriculture, including no specialized crop except tobacco, and the manufacture of safety blasting fuse.

SURFACE FEATURES.

Avon includes portions of three valleys and of three ranges of hills. The highest point is on the crest of Talcott Mountain at the north

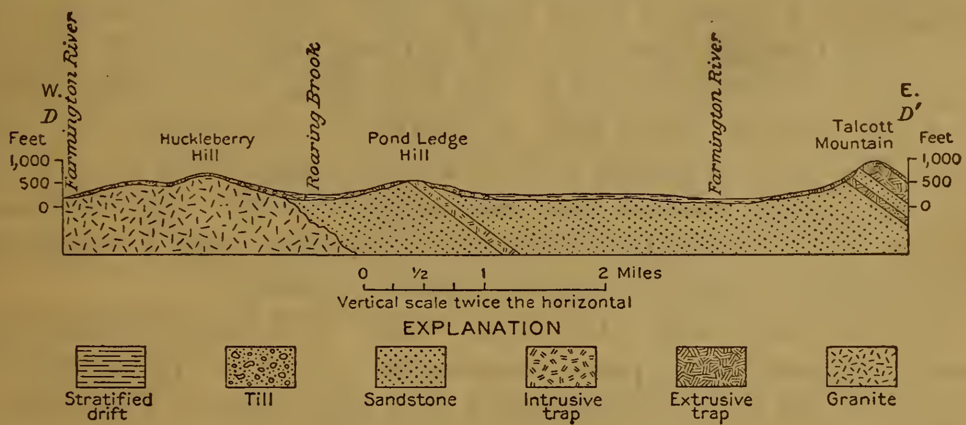

FIGURE 18.—Section across Avon.

boundary and is 940 feet above sea level, and the lowest is where Farmington River crosses the north boundary, at 140 feet above sea level. The highest and lowest points are less than a mile apart. The profile and structure section reproduced in figure 18 show the topographic and geologic features of Avon. (See also section *D–D′*, Pl. II.)

The crest of Talcott Mountain is 600 feet above sea level at the south boundary of Avon and rises gradually northward to its maximum but is broken by three shallow gaps. The mountain has a steep western face, with trap cliffs at the top. South of the so-called Talcott Mountain Road from Avon to West Hartford, the cliffs are formed by the "Anterior" trap sheet, and east of the brow the "Main" sheet forms a small cliff. This is unusual, as in general the prominent cliffs are formed by the "Main" sheet, and the edge of the "Anterior" sheet is buried beneath the talus below the cliff. North of the Talcott Mountain Road the normal relations prevail, the "Main" sheet forms the cliff, and the "Anterior" sheet is concealed.

A northward reach of Farmington River flows past the west foot of Talcott Mountain. It receives three or four small brooks from the mountain and two fair-sized and two small brooks from the west. The largest of these is Nod Brook, which supplies the reservoir of the Avon Water Co. and flows through the village of Avon.

West of Farmington River is a sandy plain 2 miles wide, which undulates gently between altitudes of 200 and 340 feet above sea level. It is a glacial outwash plain which has been dissected by postglacial stream erosion. At West Avon there is a kettle hole, a nearly circular depression in the stratified drift, formed by the melting of a stranded and partly buried block of glacial ice. Between the outwash plain and Farmington River is a flood plain with a maximum width of half a mile. It is on this flood plain that most of the tobacco is grown.

West of the outwash plain is a double line of hills, the northernmost point of which is Pond Ledge Hill, 600 feet above sea level. Extending through these hills and outcropping at several places is an intrusive sheet of trap rock. By its resistance to erosion the trap sheet has enabled these hills to continue in existence. On Pond Ledge Hill the trap stands up with a steep eastern face 20 to 50 feet high and a steep western face that is partly a cliff. On the eastern face are many horizontal scratches and grooves made by rock fragments in the ice sheet as it moved down the valley

West of Pond Ledge Hill is the valley of Roaring Brook, which flows southward and joins Farmington River at Unionville. In July, 1915, its flow was estimated at 5 second-feet. This valley is approximately the boundary between the Triassic rocks and the crystalline rocks. As the lowest of the Triassic rocks are more easily eroded than the granite gneiss or the trap they have been cut away to form the valley. About three-quarters of a mile north of the south boundary of the town is an esker which extends across the whole width of the valley. It bears east-northeast, is a quarter of a mile long and 20 to 25 feet high, and is cut at the middle by Roaring Brook.

Between Roaring Brook and Farmington River, on the west, is Huckleberry Hill. At the north boundary of the town this hill is 680 feet above sea level, but toward the south it is lower. Its prominence is due to its being underlain by resistant granite gneiss. Flowing down its south slope is an unnamed brook tributary to Farmington River which in July, 1915, flowed a scant second-foot. This brook supplies the reservoirs of the Unionville Water Co.

WATER-BEARING FORMATIONS.

The principal water-bearing formations in Avon are the till and stratified drift. No wells, except a few in trap, were found which drew water from the consolidated rocks.

Trap rock.—On the crest of Talcott Mountain are a number of cottages and more pretentious summer residences that are supplied by springs and drilled wells. One residence has an extensive system in which water from a ponded brook fed by springs is pumped into a standpipe. Mr. R. T. H. Barnes's well (No. 60, Pl. III) draws its water from fissures in the "Anterior" trap sheet. As the well is only about 300 feet back from the cliff it is remarkable that it should reach a fissure bearing a dependable supply within 98 feet. Were the rock very thoroughly fissured the water would run out at the cliff face in springs. The trap rocks of Pond Ledge Hill have not been used as a source of supply.

Red sandstone.—The Triassic red sandstone, so far as information was obtained, is not used as a source of supply anywhere in the town of Avon. This rock underlies all of the area between the trap cliffs of Talcott Mountain and Roaring Brook except the trap areas in Pond Ledge Hill and its southward prolongation. In most places in the outwash-plain region the sandstone is deeply buried by stratified drift in which drilled wells obtain good supplies. Wells Nos. 14 and 49 (Pl. III) are 90 and 85 feet deep, respectively, and do not reach bedrock. Undoubtedly the sandstone carries water in fissures, but the water in the stratified drift is more accessible and probably more abundant. Pond Ledge Hill has a sandstone and trap core covered by 10 to 30 feet of till. Water could probably be advantageously recovered from the sandstone but has not yet been utilized at any place.

Granite and gneiss.—The rock core of Huckleberry Hill is a granitic mass which has been called the Collinsville granite gneiss because it is well exposed in Collinsville. Most of the rock is a granite, though there is considerable variation in the amount of mica, and some of it is gneissic. The transition from granite to gneiss is almost imperceptible. Joints and fissures exist in this rock as in the other crystalline rocks of Connecticut, and some of them undoubtedly carry water that could be recovered by drilled wells. No such developments have been made, however.

Till.—Till forms the surface material of Avon above an elevation of about 300 feet above sea level except the hill east of West Avon, 340 feet in altitude, which consists entirely of stratified drift, and numerous areas of bedrock, the principal ones of which are shown on Plate II. The till, or "hardpan" as it is locally called, was formed by the ice sheet which overrode this region, and is composed of various sorts of material in particles of all sizes from fine rock flour to large boulders. These materials were scraped up and shoved along by the ice as it moved slowly southward and were deposited as a thoroughly heterogeneous mass, except locally where a part was washed and sorted by running water. In Avon many dug wells obtain reliable supplies from the dense till, but a few of the most copious

supplies come from the more porous, partly washed till. The failing of wells in till is an unavoidable trouble, but deepening may be beneficial, particularly if a porous zone is reached. It is generally inadvisable to deepen by blasting a well that already is dug to bedrock, for although a water-bearing fissure may thus be cut this process is more uncertain and more expensive than drilling would be.

In 17 till wells measured in Avon the average depth to the water table was 15.6 feet, the maximum 35.2 feet, and the minimum 2.3 feet. The greatest fluctuation of water level was observed in well No. 19 (Pl. III), which contained 10.7 feet of water at the time it was measured (July 7, 1915), but was reported to fail in prolonged droughts. The fluctuation of well No. 3 is presumably not very great, for it had only 3.1 feet of water on July 8, 1915, when the water table was rather high, and it is said never to fail.

Stratified drift.—Stratified drift underlies the broad plain in eastern Avon and the floor of Roaring Brook valley. Patches of it lie on the lower western slopes of Huckleberry Hill, and one patch that forms an esker and a small kame area lies on the crest of the ridge south-southeast of Huckleberry Hill. The deposits of stratified drift on the western slopes of Huckleberry Hill are in part recent terraces of Farmington River, flat-topped, and 15 to 20 feet above the water level, and in part older terraces plastered against the hillside as much as 50 feet above the water level. The kames and eskers are of interest in that they indicate a halt in the retreat of the ice sheet, but they are of little consequence as sources of water, as they are of slight areal extent and are situated on slopes where any water they receive drains quickly away.

The sand and gravel of the plain of eastern Avon were washed from the front of the receding ice sheet. The finest materials were mostly carried away, so that the deposits are clean and very porous. These extensive deposits are the best water-bearing beds in the town and would no doubt yield large quantities of water to bored or driven wells. A large part of the rain falling on the plain percolates downward to the water table or surface below which the deposit is saturated with water. The depth to the water table varies with the amount of rain and also from place to place. In general it is least in valleys and near streams and greatest on the divides.

In 34 dug wells in stratified drift in the town of Avon the average depth to the water table was 17.1 feet, and the maximum was 49.3 feet in well No. 12 (Pl. III). The greatest indicated fluctuation of the water level was in well No. 28, which fails in dry seasons, though it contained 4.7 feet of water in October, 1915. The minimum fluctuation indicated was in well No. 48, which is said not to fail but which had only 1.3 feet of water in July, 1915, when the water table was high. In general the fluctuation is less in wells in stratified drift than in till wells.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Avon.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1		Slope	430	22.1	21.7	Windlass rig	Fails.
2		do	350	9.1	4.3	Chain pump	Unfailing.
3		do	340	5.4	2.3		Do.
4		do	550	26.3	19.3	Windlass rig	Fails. Mostly through rock.
5		Hilltop	515	23.2	16.7	do	Unfailing.
6		Slope	490	17.0	15.7	do	Fails.
7		do	480	10.9	4.5	Chain pump	Unfailing.
8		do	360	22.1	17.4	do	Fails.
10		do	370	16.6	12.4		Do.
11		do	295	39.7	35.2	Windlass rig	Do.
17		do	320	18.8	17.4	do	Do.
19		do	350	27.4	16.7	House pump	Do.
20		Hilltop	400	18.1	7.4	do	
21		Slope	365	12.2	6.4	Deep-well pump	Unfailing.
57		do	270	39.5	33.2	Windlass rig	Fails.
58	B. J. Miller	do	215	24.4	22.4	do	For assay see p. 72.
61		Swale	650	11.5	2.5		Fails; overflows in wet seasons.

Dug wells ending in stratified drift in Avon.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
12		Slope	275	53.8	49.3	Windlass rig	Unfailing; abandoned.
13		do	275	7.6	5.2	Windmill	Tiled; unfailing.
15		do	285	13.8	10.0	Windlass rig and pump in house.	Fails; rock bottom.
16		do	295	17.1	12.5	Windlass rig	Unfailing.
18		do	305	10.3	6.8	Chain pump	Do.
23		Plain	290	22.1	19.8	Windlass rig	Unfailing; fluctuation of water level slight.
24		Slope	320	30.8	30.0	do	Tiled.
25		Plain	300	18.3	15.8	do	Unfailing; abandoned.
26		do	305	18.5	15.5	Chain pump	Fails.
27		do	295	21.9	20.2	Deep-well pump	Unfailing.
28	J. C. Thompson	do	270	20.6	15.9	House pump	Fails.
29		do	290	21	10	Two-bucket rig	Unfailing; abundant.
30		do	325		20	Deep-well pump	Rock bottom.
32		Swale	235	7.0	5.2	do	Unfailing.
33		Plain	220	10	6		1½-inch driven well.
34		do	205	12.6	8.4	Windlass rig	Unfailing.
35		do	200	20.9	16.2	do	Do.
36	Mrs. C. C. Wheeler	do	195	23.2	21.4	Chain pump	Unfailing; for assay see p. 72.
37		do	190	23.8	22.1	Windlass rig and house pump.	Unfailing.
38		do	190	28.8	25.7	Windlass rig	Do.
39		do	190	26.0	24.4	do	
40		do	190	28.6	27.3	do	Fails.
42		do	170	12.1	9.3	Chain pump	
43		do	195	23.5	22.1	House pump	
44		do	190	21.5	18.5	Chain pump	Fails.
45		do	190	12.9	9.9	do	
47		do	210	8.7	4.7	do	Unfailing.
48		do	205	13.3	12.0		Do.
50		do	155	20.1	19.6		Unfailing; abandoned.
51		do	155	24.9	22.5		Unfailing.
52		do	180	15.9	12.4	Single-bucket rig	Fails.
53		Slope	170	24.8	20.9	Windlass rig	Unfailing.
55		do	195	17.8	12.7	do	Do.
56		do	280	33.2	30.0	do	Do.

Drilled wells in Avon.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Depth to water.	Diameter of well.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*In.*	*Gals.*		
14	R. V. Green...	Slope....	285	90	90	......	6	......	Stratified drift.	
41	Fred Dimock..	Terrace edge.	180	50	50	20	6	10	...do......	Water enters through screen at bottom of well; for analysis see below.
49	W. H. Strong..	Plain....	150	85	(a)	20	......	15	...do......	For assay see below.
60	R.T.H.Barnes	Hilltop..	680	98	5	......	......	......	Trap.....	

a Does not reach bedrock.

Springs in Avon.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Ft.	*° F.*	*Gals.*	
9	....	Slope..........	390	49	....	
22	Rev. C. K. Flanders...	At brookside..	275	....	a 2	
31	....	...do.........	270	57	....	Pump from house.
46	....	Slope..........	227	....	2	
54	L. F. North............	At brookside..	210	52	....	Runs by gravity to house; for analysis see below.
59	....	Talus slope....	580	50	a 5	Roadside spring.

a Estimated.

QUALITY OF GROUND WATER.

In the following table are given the results of two analyses and three assays of samples of ground water collected in the town of Avon. The waters are low in mineral content and are of the calcium-carbonate type. All are soft and suitable for most uses. None will cause foaming or yield much scale in boilers.

Chemical composition and classification of ground waters in Avon.

[Parts per million; samples collected Nov. 24, 1915; S. C. Dinsmore, analyst. Numbers at head of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 71-72.]

	Analyses.a		Assays.b		
	41	54	36	49	58
Silica (SiO_2)	7.5	18	....	....	....
Iron (Fe)	.20	.05	Trace.	Trace.	0.75
Calcium (Ca)	23	16	....	....	....
Magnesium (Mg)	8.5	3.0	....	....	....
Sodium and potassium (Na+K)c	1.0	1.4	7	4	5
Carbonate radicle (CO_3)	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	51	49	71	85	63
Sulphate radicle (SO_4)	26	9.0	5	Trace.	5
Chloride radicle (Cl)	17	3.0	6	4	4
Nitrate radicle (NO_3)	2.0	2.0	....	....	....
Total dissolved solids	121	78	c 93	c 95	c 83
Total hardness as $CaCO_3$	c 92	a 52	57	68	52
Scale-forming constituentsc	90	70	70	85	65
Foaming constituentsc	3	4	20	10	10
Chemical character	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosiond	(?)	(?)	N	N	N
Quality for boiler use	Good.	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.

a For methods used in analyses and accuracy of results, see pp. 59-61.
b Approximations; for methods used in assays and reliability of results, see pp. 59-61.
c Computed.
d Based on computed value; N=noncorrosive; (?)=corrosion uncertain.

PUBLIC WATER SUPPLY.

Since December, 1910, Avon has been supplied by the Avon Water Co. Water from a reservoir on Nod Brook west of the village is delivered by gravity, through about a mile of main, to two hydrants and 52 service taps. About 175 of the 300 people in the village are supplied. Should it ever become necessary to increase the supply it could be done best by further development of the basin of Nod Brook, which is not yet fully utilized. The flows of several small, unused drainage basins on the flank of Talcott Mountain are so small that they would probably not warrant the investment necessary for utilization unless the sanitary condition of Nod Brook made them peculiarly valuable. Batteries of driven wells across the valley of any of the brooks entering Farmington River from the west would yield abundant supplies.

Some of the tobacco planters along Farmington River have installed small pumping plants which draw water from the river for use in their starting beds. Planters farther from the river could get water on rather low ground from properly constructed wells. Suggestions as to the best way of constructing such wells are given on pages 39–46.

BARKHAMSTED.

AREA, POPULATION, AND INDUSTRIES.

Barkhamsted is in the northeast corner of Litchfield County but is separated from Massachusetts by the town of Hartland, which is in Hartford County. The area of Barkhamsted is about 39 square miles, of which three-fourths is woodland. There are settlements with stores and post offices at Riverton, in the northwest corner of the town, at Pleasant Valley, near the south line, and at Barkhamsted, in the valley of East Branch of Farmington River. The Central New England railway crosses the southwest corner but maintains no station within the town. A star postal route connects Riverton with Winsted, and a similar route also connects Riverton, Pleasant Valley, and Barkhamsted with New Hartford. There are 80 miles of roads, of which 5 miles are State road. The town-worked roads are in general fair, though the grades are severe in many places. The State road is part of the excellent bituminous macadam trunk line between New Hartford and Winsted.

Barkhamsted was incorporated as a town in October, 1779. Previously it had been only very sparsely settled, but at this time its growth began. The largest population was shown in the census of 1830, and since then the population has decreased from 44 to 22 per square mile. The cause of the decline is the inability of this area to compete successfully with the western farming districts on account of the rough topography and the stony soil, which make cultivation

very difficult. The town is not well situated for manufacturing, on account of transportation difficulties, so that many of the people have moved to manufacturing towns or to better farming districts. There is little probability of much future growth, although as a summer resort much could be made of the scenic attractions of Barkhamsted.

Population of Barkhamsted, 1756 to 1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.	Year.	Population.
1756	18	1800	1,437	1840	1,571	1880	1,297
1774	250	1810	1,506	1850	1,524	1890	1,130
1782	503	1820	1,592	1860	1,272	1900	864
1790	....	1830	1,715	1870	1,439	1910	865

[a] Connecticut Register and Manual, 1915, p. 652.

The principal industries of Barkhamsted are agriculture and the manufacture of turned wooden articles, particularly rakes.

SURFACE FEATURES.

Barkhamsted is a typical highland town, except that it is deeply trenched by three valleys. The valley of East Branch of Farmington River runs southward across the eastern part of the town. In the northwest corner Still River enters the town from Colebrook and at Riverton unites with West Branch of Farmington River, which flows south-southeastward through a deep valley and finally empties into Greenwood Pond near the south boundary. Morgan River, or Mohawk Brook as it is sometimes called, flows eastward across the southern portion of the town and also enters Greenwood Pond. It is formed by the junction of Morgan Brook and Mallory Brook near the Winchester line.

Barkhamsted comprises a dissected plateau and three deep river valleys cut into it. The remnants of the plateau are 1,000 to 1,140 feet above sea level, and above them rise a few residual mountains such as Pine Mountain, which has an elevation of 1,420 feet. The valley floors are from 400 to 680 feet above sea level, and the smaller streams are the less deeply intrenched. A very striking feature of these valleys is that their middle and lower slopes are very steep and in places even precipitous.

On each side of West Branch near Pleasant Valley, at an elevation of 800 feet above sea level, there is a well-developed terrace. The profile across Barkhamsted (section *B–B′*, Pl. II) given in figure 19 shows the dissected plateau, the deep, steep-sided valleys, and the 800-foot terrace. In studying the profile it must be borne in mind that Barkhamsted is traversed by three good-sized streams, which with their tributaries have very extensively destroyed the plateau, which now is marked only by the high points. In regions more

distant from master streams, such as East Hartland, the plateau is much better preserved. The dissected plateau is believed to be a portion of a marine terrace, known as the Litchfield terrace.

The valley of East Branch of Farmington River trends southward and is very straight. At no point does the stream lie more than a third of a mile from a straight line drawn along its general course. The cross section of the valley shows a flat floor of stratified drift from a quarter to half a mile wide, bordered by steep rock slopes 200 to 500 feet high. A valley of this type is called a U-shaped valley and is believed to be the result of glaciation. Further evidence of its glacial origin is seen in the lateral moraines plastered against the rock slopes in Hartland. (See p. 138.) One who goes through the valley receives an impression of grandeur seldom experienced in Connecticut. Equally fine are the views from some of the spurs that project into the valley from the general line of the walls. The gradient of the stream is only 15 feet to the mile.

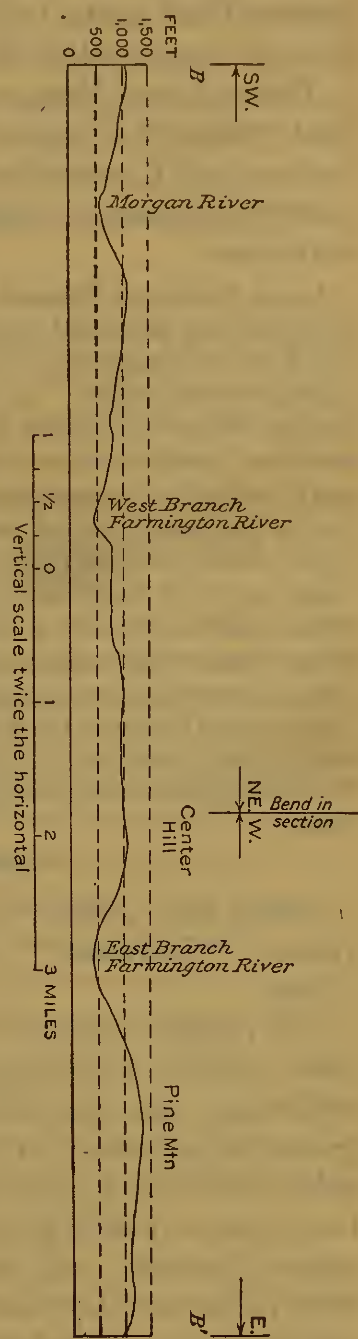

FIGURE 19.—Profile through Barkhamsted.

Beaver Brook, the only tributary to East Branch from the west, roughly bisects the wedge of country between East and West branches. For the last mile and a half it flows across a stratified-drift plain with a mean gradient of 35 feet to the mile. In its upper course it drains a till-covered area and flows with an average gradient of about 100 feet to the mile. This valley, together with the valley of East Branch, is to be flooded by a dam now under construction by the Hartford Board of Water Commissioners. The dam will be in New Hartford a mile south of the Barkhamsted line but will back up water nearly to Barkhamsted village in East Branch and about half a mile up Beaver Brook.

Several tributaries enter East Branch from the east after descending steep, ravine-like valleys from the plateau. Their beds are cut into rock in many places.

West Branch of Farmington River occupies a valley like that of East Branch in that it has steep rock walls, a low gradient, and a flat floor of stratified drift, but it is more sinuous and its flat floor is nar-

rower. No large tributaries join it from the east, but a number come in from the west, including Still River and Morgan River. The valley of West Branch is also a glacially deepened valley. It has been dammed half a mile below the New Hartford line, forming an artificial body of water called Greenwood Pond.

The valley of Morgan River or Mohawk Brook is so wide and deep that evidently it has not been carved by this stream. When the valley was cut it must have been occupied by a much larger and more powerful stream, as explained by Rice and Gregory [39] in the following statement:

> In the vicinity of Winsted the arrangement of tributaries to the upper Farmington in glacial and preglacial times was very different from the present. Mohawk Brook, which is now a small stream entering the Farmington near Pleasant Valley, has passed through several stages. At one time, previous to the glacial period, Mohawk Brook and Mad River at Winsted were parts of the same stream and drained a considerable area from Norfolk eastward. Later the Naugatuck River worked up through Winsted and captured the western (upper) part of this stream, so that Mad River became a tributary to the Naugatuck and reached the Sound by way of the Housatonic. The advent of the ice sheet modified this drainage considerably; a dam was built in the Naugatuck Valley, south of Burrville, by material left by the glacier, and similar deposits in East Winsted served to close up the channel through the Mohawk to the east. These two dams formed a lake which extended over the present site of Winsted, from Robertsville to Burrville, into which Mad River drained from the west. These glacial dams were built so high that the lowest part of this newly made lake basin was at the north, and the lake overflowed into Sandy Brook, thence into the Farmington near Riverton. The stream which wanders along the floor of the extinct lake is significantly called Still River.

WATER-BEARING FORMATIONS.

Schist and gneiss.—The bedrocks of Barkhamsted include the Hoosac ("Hartland") schist, Becket granite gneiss, and Berkshire schist.

The Hoosac schist, which underlies the part of Barkhamsted east of Each Branch of Farmington River, is a light to dark gray mica schist with many thin igneous intrusions. Some of the weathered parts are greenish gray owing to the presence of chlorite, and others are stained yellow or brown by iron oxides. The rock is made up of flakes of mica, both light and dark, granules of quartz and feldspar, and less abundant garnet, kyanite, and staurolite. The parallel arrangement of the mica flakes and elongated crystals of the other minerals make it highly schistose and cleavable. The schistose layers are roughly parallel but highly contorted and folded. The forces that produced the folded and schistose structures also fractured and faulted the rock extensively. The fractures undoubtedly carry water which might be obtained in moderate quantities by drilled wells. The fissures are vertical or steeply inclined for the most part—an attitude which, though disadvantageous, does not at all preclude the possibility of obtaining water. No developments of water from the Hoosac schist were noted

[39] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, pp. 253-254, 1906.

in Barkhamsted, but elsewhere drilled wells draw water from this formation.

The Becket granite gneiss underlies that portion of Barkhamsted west of East Branch of Farmington River, except a little of the northwest corner. Its gneissic character is due to its make-up, for it is composed of alternating layers rich in quartz and feldspar and layers in which mica is predominant. Like the Hoosac schist the Becket granite gneiss is fractured and jointed. In general, too, the fractures are nearly vertical, so that the water conditions are essentially the same.

Underlying an area about 3 miles long and a mile wide in the northwest corner of the town along the west boundary is the Berkshire schist. It is essentially like the Hoosac schist except that it is generally more thoroughly weathered and shows greenish colors due to chlorite or red and yellow stains of iron oxides. It is believed to be the same as the Berkshire schist of Massachusetts and New York. The statements made above concerning the water conditions in the Hoosac schist apply equally to the Berkshire schist.

Till.—The surface material in Barkhamsted is chiefly till but includes some stratified drift. The till, which is also known as boulder clay or hardpan, forms a mantle averaging perhaps 20 feet in thickness though in places it is much thicker and in others it is absent, leaving the bedrock exposed. The till mantle consists of all the detritus carried along by the ice sheet of the glacial epoch and deposited in a thoroughly mixed condition, generally without any manifestation of sorting or washing. A well dug in material of this kind, if deep enough, and not on a steep slope or in some other disadvantageous position, has sufficient surface exposed below the water table for water to seep into it in quantities large enough for domestic and farm demands. Should such a well fail in dry seasons the remedy is to dig it deeper, so that it may extend some distance below the lowest level that the ground water reaches in extreme droughts. If the well already reaches bedrock it is inadvisable to blast into rock, but a new well should be dug in a more advantageous position or should be drilled.

Within the till there are some lens-shaped masses of material from which the finest particles have been washed and the residue partly stratified. Such lenses are more porous than the rest of the till and where penetrated by dug wells give abundant supplies of water. They are locally called "veins" or "springs." Unfortunately there is no way of determining the presence or absence of such lenses before digging a well.

The average depth of the water in the 62 wells dug in till that were measured in Barkhamsted was 9.2 feet, the range being from 2.7 feet in well No. 36 (see Pl. III) to 22.6 feet in well No. 41. The reliability of 46 of these wells was ascertained; 29 were said to be nonfailing, and 17 were said to fail.

Stratified drift.—Stratified drift forms the valley fill along the entire length of both East Branch and West Branch of Farmington River, and small patches occur at several points along Morgan River. These deposits were laid down by the large volumes of water which flowed down the valleys in late glacial time. Where the gradient was low the current was sluggish and therefore the water dropped some of its burden of detritus. Along both branches of the Farmington the gradient was low and the deposits are consequently continuous, but the fill in Morgan River valley is broken because the gradient was high and the stream had sufficient velocity most of the way to carry its load along. Beaver Brook is very steep north of Goose Green and was able to carry a large amount of detritus, but much of this material was dropped when it reached the less steep portion of its course, forming the area of stratified drift east and southeast of Goose Green. In the northeast corner of the town there is an area of stratified drift which has a similar origin.

The stratified drift is nearly free of fine particles and consists chiefly of very porous sand and gravel. Water seeps much more rapidly into the wells in the stratified drift than into the wells in till, and therefore the supply is more abundant. The fluctuation of water level is less than in till on account of the greater ease and rapidity of circulation, so that if a well in stratified drift reaches the water table it is less likely to fail.

Measurements of 11 wells dug in stratified drift in Barkhamsted showed that the depth to water averaged 11.9 feet and ranged from 4.3 feet in well No. 44 to 17.5 feet in well No. 65. (See Pl. III.) Of these wells six were said never to fail and three were said to fail, but the reliability of the other two was not ascertained.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Barkhamsted.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
3	....	Slope....	780	27.5	19.3	Chain pump..........	Unfailing.
4	....	...do.....	785	17.2	13.8	.....do...............	Fails; abandoned.
5	....	...do.....	560	18.4	15.9	Windlass rig..........	Fails.
8	....	...do.....	790	16.0	6.1	Chain pump..........	Unfailing.
9	....	...do.....	830	13.8	5.5	.....do...............	Fails.
10	....	...do.....	890	16.0	7.8	.....do...............	Do.
12	....	...do.....	1,025	20.0	7.9	.....do...............	Unfailing.
13	....	Flat hilltop.	1,015	15.1	4.4	.....do...............	Do.
15	....	Slope....	930	10.9	4.8	Windlass..............	Do.
16	....	...do.....	930	18.4	11	Deep-well pump......	
17	....	Flat hilltop.	1,045	26.1	3.7	.....do...............	Fails.
18	....	Slope....	1,040	18.3	15.7	....	
19	....	...do.....	730	7.5	4.5	Gravity system.......	
21	....	...do.....	890	27.3	6.1	Chain pump..........	Unfailing.

Dug wells ending in till in Barkhamsted—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
22		Slope	890	17.5	15.8	Windlass and pulley rig.	Fails; water enters from fissure in rock.
23		do	960	13.9	6.6	Chain pump	Fails.
24		do	600	22.6	14.7	do	Unfailing.
25		do	580	13.9	8.3	Pitcher pump	Do.
26		do	580	14.8	13.0	Chain pump	Do.
27		Plateau	990	19.8	11.6	do	Do.
28		do	1,005	12.9	5.8	do	
29		do	1,050	13.3	5.3	(a)	Do.
31		Slope	880	13.7	7.2	Deep-well pump	Do.
32		Hilltop	1,025	18.9	13.5	Chain pump	Do.
33		Slope	945	22.9	13.5	Windlass rig	Unfailing; never less than 4 feet of water.
34		do	815	10.4	2.7	Chain pump	Fails.
36	F. J. Church	do	520	7.2	2.7	Gravity system	For analysis see p. 80.
37		do	600	16.1	7.6	Windlass rig	
38		Hilltop	610	17.4	9.5	do	Fails.
39	Parsonage	do	620	20.4	10.5	Chain pump	Unfailing; for assay see p. 80.
40		Slope	530	12.1	7.9	do	
41		do	555	32.3	12.3	do	
42		do	500	15.9	12.3	Pitcher pump	Fails.
45		do	500	7.7	2.9	Gravity system	Unfailing.
46		do	600	20.1	2.8	Chain pump	Do.
47		do	960	16.3	12.1	Windlass rig	
48		do	890	26.1	13.1	do	
49		do	1,020	16.5	6.7	Chain pump	Do.
50		do	1,055	19.3	12.0	Windlass rig	Do.
51	C. M. Tolson	do	1,150	13.1	7.3	Chain pump	Fails.
52	do	do	1,172	14.0	11.4	House pump	Do.
53	do	do	1,165	13.8	10.9	(a)	Unfailing.
54	do	Hilltop	1,185	17.8	12.9	(a)	
55		Slope	1,150	16.2	5.5	(a)	Do.
56		Hilltop	1,125	13.0	7.8	(a)	Fails.
57		Slope	1,235	18.3	2.8	Windlass rig	Unfailing.
58		do	1,090	18.0	6.8	(a)	
59		do	950	13.8	8.1	Two-bucket rig	Do.
60		do	1,035	11.0	5.7	House pump	Fails.
61		Hilltop	1,115	15.1	8.1	(a)	Unfailing.
66		do	435	13.9	12.6	Windlass	Do.
67		Slope	480	18.2	8.4		
68	J. N. Lockwood.	do	505	19.3	12.9	do	Do.
69		do	475	10.0	7.1	Chain pump	Do.
72		Slope	530	16	8		Fails.
73		do	610	19.5	15		
77		do	770	10.4	2.2	Gravity system	Unfailing.
78		do	870	13.8	7.1	(a)	
79		do	1,025	10.3	5	Gravity system	Do.
80		do	1,088	30.7	10.4	Windlass rig	Fails.
81	W. E. Manchester.	Plain	425	16.5	15.5	do	Do.
82		Slope	510	16.4	12.8	do	

a No rig.

Dug wells ending in stratified drift in Barkhamsted.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
2		Plain	515	15.6	13.6	Pitcher pump	Unfailing.
6		do	530	15.8	14.0	Chain pump	Do.
35		do	430	13.0	11.5	House pump	Fails.
43		Slope	560	18.1	14.4	Two-bucket rig	Do.
44		do	480	16.4	4.3	(a)	
62		Plain	430	13.0	10.5	Windlass	Unfailing.
63		do	430	13.8	13.0	do	Do.
65		do	425	18.3	17.5	Chain pump	Do.
71	M. B. Frazier	do	425	19.6	15.7	do	Unfailing; for assay see p. 80.
75		do	405	10.5	10.0	(a)	Fails.
76		do	410	10.6	6.0	Chain pump	

a No rig.

Springs in Barkhamsted.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	° *F.*	*Gallons.*	
1	....	Foot of slope.	540	53	....	
7	....	...do.....	515	53	....	
11	....	Slope....	1,040	50.5	1	Unfailing; piped to house.
14	....	...do.....	900	54	....	Unfailing; masonry reservoir.
20	....	...do.....	680	62	....	Piped to house.
30	....	...do.....	1,000	51	....	Fails.
64	W. E. Manchester........	...do.....	500	....	....	Piped to house; for analysis see below.
70	....	...do.....	460	50	....	Piped to house.
74	....	...do.....	425	58	....	Do.

QUALITY OF GROUND WATER.

In the following table are given the results of two analyses and two assays of samples of ground water collected in Barkhamsted. The waters are soft, are low in mineral content, and are calcium-carbonate in type with the exception of No. 39, water from dug well at parsonage, which is sodium-carbonate in character. They are suitable for most domestic and industrial needs. In boilers they would yield only small amounts of scale and would give no trouble from foaming.

Chemical composition and classification of ground waters in Barkhamsted.

[Parts per million; samples collected Nov. 30, 1915; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 79–80.]

	Analyses.[a]		Assays.[b]	
	36	64	39	[c] 71
Silica (SiO_2)	12	10	....	....
Iron (Fe)	.04	Trace.	Trace.	Trace.
Calcium (Ca)	7.5	8.0	....	....
Magnesium (Mg)	2.1	2.1	....	....
Sodium and potassium (Na+K) [d]	7.1	.5	16	2
Carbonate radicle (CO_3)	.0	.0	0	0
Bicarbonate radicle (HCO_3)	44	20	37	26
Sulphate radicle (SO_4)	3.7	3.7	10	Trace.
Chloride radicle (Cl)	2.0	5.0	14	6
Nitrate radicle (NO_3)	.0	3.0	....	....
Total dissolved solids	54	43	[d] 84	[d] 47
Total hardness as $CaCO_3$	[d] 27	[d] 29	29	25
Scale-forming constituents [d]	38	37	45	40
Foaming constituents [d]	19	1	40	10
Chemical character	Ca-CO_3	Ca-CO_3	Na-CO_3	Ca-CO_3
Probability of corrosion [e]	N	(?)	N	(?)
Quality for boiler use	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used in assays and reliability of results, see pp. 59–61.
[c] Sample collected November 20, 1915.
[d] Computed.
[e] Based on computed value; N=noncorrosive; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

There are no public water supplies in Barkhamsted, except a small communal system that supplies a number of houses in Riverton and obtains its water from a group of wells on the hillside southwest of the village.

The reservoir which the Hartford Board of Water Commissioners is constructing on East Branch of Farmington River is not to supply water for general consumption but is to augment the summer flow of Farmington River, in order to compensate the owners of power rights for the loss of flow that will result from the utilization of Nepaug River for public consumption in Hartford. (See p. 166.)

Should it ever become desirable to have public supply in Barkhamsted it would be practicable to develop such a supply by building a dam on Beaver Brook or Morgan River. Abundant supplies could undoubtedly be pumped from batteries of driven wells along either branch of Farmington River, but the cost of pumping would preclude competition with surface supplies.

BRISTOL.

AREA, POPULATION, AND INDUSTRIES.

Bristol is near the southwest corner of Hartford County. The principal settlement is the city of Bristol, near the center of the town. Forestville, in the eastern part, is a good-sized village, and near the northeast corner is a small settlement sometimes called Polkville and sometimes Edgewood. The city of Bristol was incorporated in 1911 and is coextensive with the town. There are post offices at Bristol and Forestville, but the rest of the town is served by four rural-delivery routes. The Highland division of the New York, New Haven & Hartford Railroad crosses the town from east to west and has stations at Forestville and Bristol. The Plainville & Bristol Tramway Co. has trolley lines connecting Bristol with Terryville, Forestville, Plainville, and Compounce Pond. The area of Bristol is about 27 square miles, of which about 35 per cent is woodland. Within the town there are about 155 miles of roads and streets, including 8 miles of the bituminous-macadam State trunk-line highway between Thomaston and Plainville and 3½ miles of State-aid road from the northern part of the city northeastward toward Farmington station. In the eastern part of the town road building is difficult on account of large amounts of sand, and in the western two-thirds of the town there are a number of bad grades, but the roads are in general very good.

The territory which is now Bristol, together with Burlington, was taken from Farmington in 1785 and incorporated as Bristol. In 1806 Burlington was taken from Bristol and separately incorporated.

In 1920 the population of Bristol was 20,620. The table shows the changes in population from 1790 to 1910. The decrease from 1800 to 1810 was due to the cession of Burlington and does not indicate a loss of population, as the towns together grew in that decade from 2,723 to 2,895. The only loss in population in Bristol was from 1810 to 1820. Prior to 1810 Bristol had dominated the clock industry of this region, but in the next decade Plymouth took the lead because of certain superior patents owned there, and many of the Bristol people moved to Plymouth.

Population of Bristol, 1790–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1790	2,462	1840	2,109	1880	5,347
1800	2,723	1850	2,884	1890	7,382
1810	1,428	1860	3,436	1900	9,643
1820	1,362	1870	3,788	1910	13,502
1830	1,787				

[a] Connecticut Register and Manual, 1915, p. 652.

There is some farming in Bristol, but by far the greater portion of the population is dependent on manufacturing. The principal products are metallic and include bicycle and automobile parts and accessories, clocks, watches, steel fishing rods, brass goods, and all sorts of malleable and gray iron castings. There is also some knitting of underwear. As Bristol's manufacturing industries are prosperous and produce goods of a staple character it is probable that the city will continue to grow in population.

Bristol is one of the few towns in Connecticut in which there has ever been any mining. In the northeast corner of the town there is a small amount of copper ore which has been worked at different times.

SURFACE FEATURES.

The eastern part of Bristol is a portion of the plain on which Plainville, Farmington, and Southington lie, but the rest of the town is very hilly and is part of the western highland of Connecticut. The rocks underlying the eastern part are sandstones and shales which have been worn down so that the surface is only 200 to 400 feet above sea level. Prior to the glacial epoch the relief was probably somewhat greater. The ice wore off the high points and with the material thus obtained filled the depressions to some extent, partly with ice-borne and partly with water-borne detritus. The water-laid fill is restricted to areas less than 250 feet above sea level in this portion of the lowlands, and it forms a well-developed plain. Above 250 feet rise rock drumlins, gently rounded hills with roughly elliptical ground plan; they have rock cores but are mantled with till. The big area

of till in Bristol, Plainville, Burlington, and Farmington shown on the map (Pl. II) is a compound rock drumlin. At Forestville it is cut across by Pequabuck River, south of which it is farther continued as a series of rock drumlins which may be traced as far as New Haven. This ridge has been called the Quinnipiac Ridge by Davis,[40] who believes that its prominence is due to heavy sandstone beds which have resisted weathering more than the adjacent shale.

The lowland is bounded on the west by the escarpment of the highlands. South Mountain, near the Wolcott line, is 1,020 feet above sea level, or about 800 feet above the plain, but to the north the escarpment is lower. Bristol and Polkville are underlain by a variety of granite, which, although more resistant than the sandstone of the lowlands, has not withstood erosion as well as the schist to the west and southwest. Consequently, Bristol and Polkville lie in a depression intermediate in altitude between the lowlands and the adjacent highland areas.

The northwestern, western, and southwestern parts of Bristol are characteristic highland areas. In the southwest corner, for example, there are five hilltops that range from 980 to 1,020 feet above sea level and mark a plateau which formerly was very extensive but is now worn away except for a few such residual fragments. Chippen Hill, northwest of Bristol, is also a remnant of the old plateau.

The valley of Pequabuck River west of Bristol is notable for the great banks of sand and gravel plastered against the rock slopes. Some of the cuts made in the construction of the railroad expose sand banks 150 feet high. Plate IV, *B*, shows such a cut $1\frac{1}{2}$ miles east of Terryville station. The sand and gravel deposits extend over an area bounded on the south by the Pequabuck and on the north and west by the 650-foot contour, approximately, as shown on Plate II. The eastern boundary runs through the city of Bristol in a north-south direction. This whole mass of stratified drift is higher than that of the lowland, and much of it is a great deal higher. It also differs in that thin clay and silt beds, horizontal in position and of considerable lateral extent and continuity, are found in it. These features indicate that the sediments were deposited in rather quiet waters, very likely those of a lake. The most probable explanation of a lake in this position with its water level 400 feet above the plain to the east is that it must have been held up by the ice. During the recession of the continental glacier from this region there was, presumably, a lobe which projected from the general front of the ice sheet and extended from a point at least as far north as Polkville southward to South Mountain and dammed Pequabuck River and its tributaries, making a lake. Because of the rainy climate and the

[40] Davis, W. M., The Triassic formation of Connecticut: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, p. 183, 1898.

melting of much ice the streams tributary to the lake were vigorous and easily cut into the unconsolidated till and carried much sediment. The deposits seem to be rather like deltas; some of the coarser beds are very steep and highly cross-bedded like foreset delta deposits, and some of the finer ones are nearly horizontal like bottom-set delta deposits. It is probable that the valley was never filled but was merely fringed with deltas on the northwest and west sides. Had the valley been completely filled and then cut down to its present size the material would probably have been deposited as a huge alluvial fan opposite the point where the Pequabuck now debouches onto the lowland. No such cone-shaped mass is found there, and the plain is, instead, very flat. Pequabuck River has, however, cut away some of the deposits, especially at the foot of the slopes. A quarter of a mile east of Fitzpatrick's spring (No. 30, Pl. III), on the north side of the road, is a sand pit, which is illustrated in Plate V, *A*. The sands have been cut away below by the stream, thus causing small avalanches. In the process faults and folds have been made. The faults in these unconsolidated materials are accentuated by the presence along them of small amounts of clayey matter, which, as the clay is darker and crumbles less easily than the sand, are somewhat prominent. Two sets of intersecting faults are shown in the upper part of the view, and folded beds at the bottom.

In the northeastern part of the city of Bristol, on North Street an eighth of a mile west of the end of the North Street trolley line, is a high bank in which a section of beds of probable lacustrine origin is exposed. Similar clayey beds were found in a railroad cut half a mile east of Fitzpatrick's spring.

Pequabuck River, a tributary of Farmington River, flows eastward across Bristol about 2 miles from the southern boundary. Mr. C. W. Buell, of Bristol, supplied the following figures on the flow of this stream, derived from measurements made by weir about a mile below the Terryville railroad station. The average flow for the year is calculated at about 22 second-feet.

Flow of Pequabuck River near Terryville station.

Month.	Second-feet.	Month.	Second-feet.	Month.	Second-feet.
January	38	May	20	September	7
February	34	June	17	October	10
March	38	July	8	November	22
April	23	August	5	December	36

Formerly there were a number of water powers on the Pequabuck, and these gave Bristol its original impetus in manufacturing. Most of them have now been outgrown and are abandoned.

A. FAULTED AND FOLDED STRATIFIED DRIFT IN THE FILL OF PEQUABUCK VALLEY.

B. KETTLE HOLE AT BURLINGTON CENTER.

Marsh Brook, which flows across the northwest corner of the town and then through Plymouth and into Pequabuck River, was also studied by Mr. Buell. He made 39 weir measurements between June 2, 1909, and May 31, 1910. These measurements were well distributed and indicated an average flow of about 2¼ second-feet.

North Branch flows southward through Bristol about 1½ miles from the eastern boundary and enters the Pequabuck at Forestville. Several float measurements were made on this stream and its tributaries, and the results are given in the table below. The point at which each measurement was made is indicated by bearing and distance from a well near by. (See Pl. III.)

Flow of North Branch and its tributaries.

Place.	Date.	Flow (second-feet).
¼ mile south of well No. 100	Sept. 24, 1915	3.7
¼ mile west of well No. 115	do	5.7
500 feet south of well No. 91	do	.7
400 feet west of well No. 126	Sept. 30, 1915	5.4
Between wells Nos. 187 and 188	Sept. 25, 1915	.1

WATER-BEARING FORMATIONS.

Underlying Bristol there are three varieties of bedrock—the Hoosac schist, the Bristol granite gneiss, and red sandstone of Triassic age. There are several wells in the town that obtain water from the gneiss and sandstone, but none which draw from the schist.

Schist and gneiss.—The Hoosac schist is a typical mica schist, light to dark gray with a silvery sheen, and very fissile. It is essentially composed of good-sized flakes of mica, both black and white, and of granules of quartz. The mica flakes are roughly parallel to one another and give the rock its prominent cleavage. The forces which metamorphosed the schist also produced joints in great number, so that fissures of large and small size abound. Many of these undoubtedly carry water which has percolated into them from the overlying soil and which might be recovered by means of drilled wells. The areas underlain by the Hoosac schist comprise the highest portions of the town, a triangular patch of about a square mile in the northwest corner, a narrow strip along the margin of the lowlands, and a strip a mile wide along the Wolcott town line.

The Bristol granite gneiss constitutes the bedrock of the rest of the highland portion of Bristol and consists essentially of feldspar and black mica with or without quartz. The quartzose phase is granitic and the quartz-free phase dioritic. Mashing has altered the simple granular texture of the rock and made it gneissoid. These changes

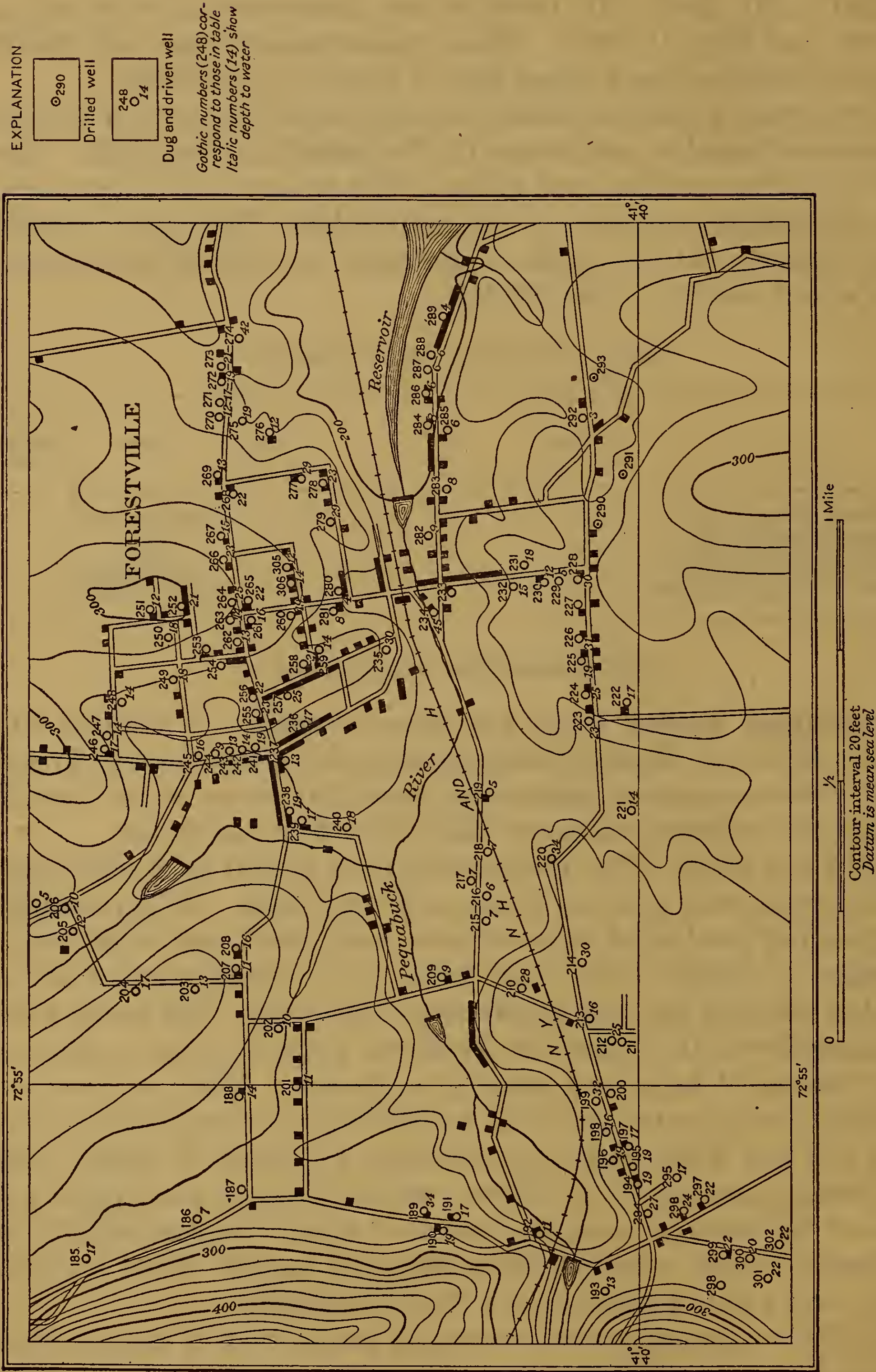

FIGURE 20.—Map of Forestville.

were accompanied by the production of fissures and joints, from which a number of the drilled wells of Bristol obtain water. Four such wells are tabulated on page 93.

Sandstone.—The lowland eastern portion of Bristol has red sandstone and shale as bedrocks. The valley of North Branch is probably underlain by more shaly rock than the ridge which follows the eastern town line. No such crushing as characterizes the Hoosac schist has occurred in these rocks, but joints and fissures have been abundantly formed as a result of block faulting and tilting to the east. In these joints and in the pores of the coarser sandstone beds there is water which may be obtained by drilled wells. Though no prediction as to the likelihood of obtaining a satisfactory supply at any particular point can be made, the probability of success is high. Three drilled wells in sandstone, all successful, were visited, and the information obtained is given in the table on page 93.

Stratified drift.—Under the heading "Surface features" the distribution and origin of till and stratified drift, the two kinds of surface material in Bristol, have been discussed.

The wells in stratified drift are not as successful as in other towns in the Southington-Granby area, because much of this material is on steep slopes from which the water drains readily. In 141 dug wells the depth to water ranged from 4.3 feet in well No. 289 (Pl. III) to 44.8 feet in well No. 234, and the average was 16.9 feet. The measurements were made in September and October, 1914, after a long drought, so that the water table was unusually low. Nine other wells visited were completely dry. Information as to reliability was obtained for 40 wells, of which 14 fail and 26 are nonfailing.

Till.—The wells dug in till that were visited in Bristol average 15.6 feet in depth to water, the range being from 3 feet in well No. 143 to 38.2 feet in well No. 61. In all 138 wells dug in till were measured. Of these 5 were dry, 12 more were said to fail, and 37 were said to be nonfailing. The reliability of the remaining 84 wells was not ascertained.

RECORDS OF WELLS AND SPRINGS.

In the following tables the numbers in the first column of each table refer to the serial numbers on the maps (Pl. III and fig. 20). It was found necessary to give a larger map of Forestville because of the great number of wells to be recorded. On the enlarged map are shown wells Nos. 185 to 302, 305, and 306. Some of these are also plotted on Plate III for convenience in cross reference.

Dug wells ending in till in Bristol.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1		Slope	810	12.0	9.5	Dipping	Unfailing.
2		do	830	11.8	10.3		
3	Mount Hope Chapel.	do	880	11.3	8.7	Chain pump	
4		Plateau	885	16.0	12.0	House pump	Do.
4a		do	880	11.5	7.5		Do.[a]
5		do	885	27.3	14.6	Windlass rig	Do.
6		do	880	17.1	14.5	Chain pump	
7		Slope	810	8.8	7.2	Windlass rig	House abandoned.
8		do	820	17.9	14.7	Windmill	
9		Valley	760	11.4	6.5	House pump	
10		Slope	825	19.7	18.1		Fails.
11		do	825	16.1	12.1	Chain pump	
12		do	795	26.3	13.0	Windlass rig	Unfailing.
15		do	670	19.1	16.2	House pump	Do.
16		Plateau	670	19.5	18.5	Deep-well pump	
17		do	665	24.1	17.0	Windlass and counterbalance rig.	Do.[b]
17a	School	do	670	25.7	13.3	do	
18		Slope	650	16.5	14.1	House pump	Fails.
19		do	700	29.9	20.9		Abandoned.
20		do	720	18.0	10.3	Chain pump and windmill.	Unfailing.
32		do	380	22.5	20.4	Windlass	Fails.
32a		do	385	24.0	21.2	Windlass and counterbalance.	Unfailing.[c]
33		do	390	18.3	15.4	House pump	Tiled.
34		do	395	29.6	24.4	Windlass	Unfailing.
35		do	400	27.3	22.9	House pump	Do.
46		Slope	920	18.8	16.2	Chain pump	Do.
47		do	920	23.6	23.2	Windlass	Fails.
48		Hilltop	940	20.0	8.3	do	Unfailing.
49		do	940	29.9	19.5	Deep-well pump	
50		do	950	25.6	24.7	Windlass	([d]).
50a		do	940	20.5	13.6	Chain pump	
50b		do	945	21.5	20.5	([e])	
51		Slope	620	33.7	31.5	Two-bucket rig	Unfailing.
52		do	400	26.1	25.3	do	([f]).
53		do	400	21.8			Fails; abandoned.
54		do	410	15.9		Chain pump	Fails.
55		do	400	19.5	16.1	do	
60		do	460	20.5	17.0	Gravity system	Unfailing.
61		do	450	40.0	38.2	Windmill	Tiled.[g]
63	R. W. Williams.	Swale	455	23.2	22.3		Fails; abandoned.
72		Slope	320	13.7	12.1		Unfailing.
76		do	380	27.6	26.3	Windlass	
76a		do	390	24.3	22.4	Windlass and house pump.	Do.[h]
77	A. S. Pons	do	305	18.0	17.4	Windlass	Abandoned for spring.
100		do	300	16.0	14.3	Two-bucket rig	Unfailing.
101		Plain	320	24.7	21.1	([e])	
102		do	320	11.0		([e])	
103		Slope	280	10.2	9.3	Windlass	Do.
105	C. E. Morris	Plain	285	24.1	23.1	Two-bucket rig	Do.
106		Slope	300	33.5	31.8	Deep-well pump	Fails.
108		Plain	335	27.1	22.9	Windlass	
109		Slope	310	8.7	8.1		
110		Flat	305	23.1	22.0		Do.
112		Slope	275	12.0	9.9	Pitcher pump	([i]).
112a		do	295	29.5	27.0	Deep-well pump	
113		do	295	22.3	18.3	Two-bucket rig	Unfailing.
114		do	275	11.0	9.1	Pitcher pump	Fails.
115		do	260	9.4	7.7	Chain pump	

[a] Well No. 4 is in cellar of house; No. 4a is 60 feet southwest.
[b] Well No. 17 is at house 100 feet southwest of road corner; No. 17a is at school house at southwest road corner.
[c] Well No. 32a is 100 feet east of No. 32.
[d] Well No. 50 is at the house; No. 50a is 150 feet west of No. 50 and 9 feet higher; No. 50b is 300 feet south of a point halfway between 50 and 50a and 4½ feet higher than 50.
[e] No rig.
[f] Blasted 2 feet into rock.
[g] Windmill with 10-foot wheel pump and 40-foot tower. Cost $93, plus freight on 1,700 pounds, $47 for dynamite, fuse, and caps for blasting into rock, and $54 for tile used above rock.
[h] 200 feet south of well No. 76.
[i] Well No. 112a is at the house; No. 112 is 200 feet south.

Dug wells ending in till in Bristol—Continued.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
116		Slope	275	23.5	18.7	Windlass	Unfailing.
117		do	330	21.1	18.8	do	Do.
118		do	335	28.3	25.0	Deep-well pump	
119		do	325	27.3	26.3	Windlass	
120		do	280	16.9	15.7	House pump	Do.
122		Plain	270	18.3	16.5	Chain pump	
123		do	270	15.0	12.0	Deep-well pump	Do.
124		Slope	285	21.4	15.9	House pump	Fails.
125		do	287	29.0	19.3	do	
133		Plain	295	16.6	12.0	Windlass and house pump.	Unfailing.
134		Slope	280	16.9	15.5	House pump	Do.
135		Plain	265	16.1	14.9	Two-bucket rig	
136		do	255	13.2	12.0	House pump	
137		Slope	300	26.9	24.2	Two-bucket rig	
138		Hilltop	305	24.9		Windlass	Do.
139		Slope	640	23.5	23.4	Two-bucket rig	Fails.
140		Valley	730	18.8	18.0	None	
141		Hilltop	815	18.5	13.6	Windlass	
142		Slope	845	15.4	14.1	do	
143		Swale	890	6.1	3.0		
144		Slope	910	21.3	18.6	Windlass	
145		do	880	18.6	14.6		Unfailing.
146		Hilltop	950	18.5	13.5	Windmill	
147		Slope	935	14.3	10.7		
148		do	905	19.9	19.3	Windlass	
149		do	900	18.8	13.2		Do.
150		do	875	12.7	12.0	Pitcher pump and air-pressure system.	3 feet in rock.
151		do	890	13.5	10.8	House pump	(*j*).
152		do	860	16.3	14.7	do	Unfailing.
153		do	840	8.6	6.0	Sweep rig	Do.
154		do	730	19.5	17.6		Tiled; abandoned.
155		do	730	19.3	16.0	House pump	(*k*).
157		do	600	16.6	13.6		
158		do	610	10.6	9.9	House pump	Fails.
159		do	615	15.7	13.6	Windlass and counterbalance.	Do.
160		do	620	10.0	8.2	Windlass and house pump.	
161		do	600	10.4	18.7		Unfailing; tiled.
162		do	590	17.6	14.1	Windlass	Unfailing.
162a		do	580	16.3	14.4	Sweep rig	(*l*).
163		do	560	27.1	22.4		
164		do	535	30.0	23.5		Tiled.
165		do	529	24.2	21.7	Windlass	
166		do	490	13.4	10.2		Unfailing.
167		do	460	21.4	18.8	House pump	Do.
167a		do	480	16.8	11.7		Do.
169		do	495	11.7	7.0	House pump and deep-well pump.	Do. (*m*).
170		do	490	24.8	14.8	Windlass	Abandoned.
171		do	500	19.9	19.0		Do.
171a		do	505	21.1	17.1	Two-bucket rig	Unfailing.
172		do	475	19.7	13.2	House pump	Unfailing; tiled.
173		do	500	17.1	15.3	Windlass	Unfailing.
174		do	360	18.7	16.7	do	
176		do	350	13.7	12.4		Abandoned.
180		Plain	230	13.3	12.0	Chain pump	
181		do	240	20.9	20.1	Windlass	Tiled at bottom.
182		Hilltop	305	25.8	23.5		
183		Slope	270	20.5	19.1	House pump	
184		do	250	9.3	8.7		
193		do	260	14.4	12.8	Gravity system	(*n*).
225		do	250	23.8	19.3		
226		do	250	35.2	31.4	Windlass	
227		do	255	20.0		Chain pump	Fails.
228		do	255	37.6	30.3	Windlass	

j This well is on a steep slope; unfailing until the road 50 feet away down the slope was lowered.
k Bottom of well planked to keep out quicksand.
l On the north side of the road, midway between Nos. 162 and 163.
m Midway between Nos. 166 and 167.
n This well is dug into a body of till which fills a trough in the bedrock. The water is siphoned to the house, which is 200 feet east and 25 feet lower than the well. On October 9, 1915, it was flowing a little over 2½ quarts a minute.

Dug wells ending in till in Bristol—Continued.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
229		Slope	250	6.7	4.9		
230		do	240	15.2	11.5	Windlass	Tiled.
231		do	230	18.1	17.9		Tiled at bottom; abandoned.
232		do	220	17.7	15.2	Windlass	Rock bottom.
251		do	300	12.6	11.6	Chain pump	
252		Hilltop	300	28.7	21.1	Windlass	Tiled; unfailing.
260		Slope	240	18.7		do	Tiled; fails.
264		do	275	26.0	25.2		Abandoned.
265		do	275	29.3	22.6	Windlass	Unfailing.
266		do	275	27.7	23.0	Chain pump	
267		do	280	19.3	14.6	do	
268		do	255	26.2	21.6	do	Do.
269		do	250	16.0	12.5	Windlass	Do.
279		do	240	32.4	28.8		
280		do	220	5.0	3.8	Chain pump	Fails.
292		do	225	5.9	3.2	Two-bucket rig	Tiled.
305		do	260	13.0	11.6	Windlass	Tiled; abandoned.
306		do	260	15.9	13.9	do	Do.

Dug wells ending in stratified drift in Bristol.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
22		Slope	680	14.5	12.4	Windlass rig and house pump.	Unfailing.
23		Plain	660	10.9	10.2	One-bucket rig	
24		Slope	665	32.2	28.9	One-bucket rig and house pump.	Fails.
25		do	670	19.8	18.5	Windlass rig	Unfailing.[a]
25a		do	660	15.5	14.5	Deep-well pump	
25b		do	650	6.6	4.5	Two house pumps	
26		do	665	26.6	23.1		
27		do	660	24.1	22.0	Windlass rig	
28		Plateau	650	30.0	27.5		Fails.
29		do	650	22.8	21.7	Windlass rig	Tiled at bottom.
31		Valley	360	17.3	14.4	do	
36		Slope	380	29.1	22.6	do	Unfailing.
37		do	460	22.7	20.3	do	Tiled; unfailing.
38		do	375	19.6	14.1	House pump	Tiled.
40		do	580	18.3	16.5	Deep-well pump	Unfailing.
41	Hubbard	do	560	25.9	25.1	Windlass rig	Fails.
43		Valley	620	11.2	10.6	Windmill	Tiled.
44	F. B. Hubbard	Plain	630	15.5	14.0	Gasoline engine and pump.	
45		Valley	610	23.0	16.2	Windlass rig	Fails.
56		Slope	395	10.3	9.3		
57		do	410	20.4	19.3	Chain pump	
58		do	400	23.0	20.7	Windlass rig	
59		do	425	27.4	26.1		Unfailing.
64		do	390	32.0	22.5		Do.[b]
65		do	390	24.7	20.7	Windlass rig	Do.[c]
66		do	380	12.4	11.0	Sweep rig	
67		do	360	10.8	10.0	One-bucket rig	
73	Wallace Barnes Co.	Plain	300	11.5	8	Steam pump	Do.
78		Slope	290	19.2	16.2	House pump	
79	J. H. Sessions & Son.	Plain	280		12	Steam pump	([d]).
82		do	265	18.8	17.1	Two-bucket rig	
83		do	255	11.5	8.5	([e])	
84		do	265	16.1	14.4	Chain pump	Fails.
85		do	270	23.6	22.1		Abandoned for spring.
86		do	265	21.4	18.8	Windlass rig	Unfailing.
88		do	260	20.1		do	Fails.
89		do	285	30.0			Fails; reaches ledge.

[a] Well No. 25 is at the house at the angle in the road; No. 25a is 100 feet west of and 7½ feet lower than No. 25; No. 25b is 200 feet west of and 17½ feet lower than No. 25.
[b] On Sept. 7, 1914, had 11 feet of water and on Sept. 27 had 9½ feet of water; least observed in 13 years was 9½ feet.
[c] Blasted 5 feet into rock.
[d] This well consists of a bricked chamber 6 feet in diameter and 16 feet high, connecting with the surface by 6 feet of large tile. Seven iron pipes, 10 to 25 feet long, with open ends, radiate from the chamber.
[e] No rig.

Dug wells ending in stratified drift in Bristol—Continued.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
90	....	Plain...	285	25.4	24.7	Two-bucket rig.....	House vacant.
91	....	Slope....	285	28.7	27.9	Windlass rig........	
92	....	Plain....	295	19.7	18.1	Two-bucket rig.....	
93	....	Slope....	295	8.3	4.9	Chain pump........	
94	....	...do.....	310	15.1	13.6	.....do...............	Unfailing.
95	C. W. Hotchkiss.	Terrace .	295	38.7	37.7	Windlass rig........	Unfailing; for analysis see p. 94.
95a	....	...do.....	300	38.7	36.0	.....do...............	Abandoned.[a]
96	....	...do.....	295	42.6	41.6	.....do...............	Unfailing.
97	M. F. Ford......	...do.....	290	31.6	....	Two-bucket rig.....	
98	....	Plain....	270	19.1	17.0	....	Do.
126	....	...do.....	230	11.4	10.7	....	
127	....	...do.....	230	10.8	7.1	Chain pump........	
128	....	...do.....	230	8.2	7.8	.....do...............	Do.
129	....	...do.....	230	9.6	8.7	Windlass rig........	Do.
130	....	Slope....	260	14.5	10.8	Gravity system.....	
131	....	Plain....	230	15.2	11.2	Deep-well pump....	
132	....	...do.....	235	5.5	4.9	Tank pump..........	
177	....	...do.....	260	26.8	26.4	Two-bucket rig.....	
178	....	Slope....	240	23.1	20.1	.....do...............	([b]).
179	....	Plain....	220	19.8	15.6	Windlass rig........	Unfailing.[b]
185	....	Slope....	260	17.5	16.5	.....do...............	
186	....	Plain....	255	10.7	7.4	House pump........	Tiled; unfailing.
187	....	...do.....	250	23.2	....	....	Fails.
188	....	...do.....	250	16.0	13.9	Windlass rig........	
189	....	...do.....	250	34.3	33.9	.....do...............	
190	....	...do.....	250	21.5	19.1	Deep-well pump....	
191	....	...do.....	250	19.4	17.1	Chain pump........	Unfailing.
192	....	Slope....	225	11.0	10.6	....	
194	....	Plain....	245	20.7	18.6	Windlass rig........	
195	....	...do.....	245	20.7	18.6	.....do...............	
196	....	...do.....	245	20.7	19.3	Two house pumps...	
197	....	...do.....	245	17.6	16.8	House pump........	
198	....	...do.....	245	17.4	16.4	Two-bucket rig.....	Fails.
199	....	...do.....	245	32.2	31.9	.....do...............	Abandoned.
200	....	...do.....	250	16.3	....	Chain pump........	Fails; abandoned.
201	....	...do.....	245	13.9	11.4	Windlass rig and house pump.	
202	....	...do.....	250	10.5	9.9	Windlass rig........	Abandoned.
203	....	Hilltop .	285	17.3	13.3	House pump........	Tiled.
204	....	Slope....	280	17.5	16.5	Chain pump........	
205	....	Plain....	225	13.3	12.3	House pump........	Do.
206	....	...do.....	245	11.3	9.9	.....do...............	Unfailing.
207	....	Slope....	270	13.4	10.8	....	
208	....	...do.....	270	19.2	16.0	Pitcher pump.......	Do.
209	....	Plain....	215	9.5	9.0	....	Abandoned.
210	....	...do.....	245	27.5	....	....	Fails; abandoned.
213	....	...do.....	250	17.3	15.8	House pump........	
214	....	...do.....	250	33.6	30.1	Windlass rig........	Unfailing; tiled.
215	....	...do.....	210	8.8	7.4	House pump........	
216	....	...do.....	210	7.2	6	.....do...............	
217	....	...do.....	210	8.8	7.4	.....do...............	
218	....	...do.....	210	8.6	6.9	.....do...............	
219	....	...do.....	210	5.9	4.9	Force pump.........	
220	....	Terrace	240	36.8	33.5	Two-bucket rig.....	Tiled.
221	....	Plain...	240	18.6	14.4	.....do...............	
222	....	Terrace	245	19.0	16.5	....	
223	....	Slope...	235	26.0	22.7	Windlass rig........	
224	....	Terrace	240	29.8	25.3	.....do...............	
233	....	Plain...	210	14.7	12.1	....	Abandoned.
234	....	...do....	210	46.7	44.8	Two-bucket rig.....	Do.
235	....	Slope...	230	32.6	30.4	....	Do.
236	....	...do....	215	18.9	16.7	Windlass rig........	Do.
237	....	Plain...	220	21.9	13.4	.....do...............	
238	....	...do....	215	20.8	18.8	.....do...............	Unfailing.
239	....	...do....	215	19.0	17.0	.....do...............	Tiled; unfailing.
240	....	...do....	210	18.9	17.9	.....do...............	Abandoned.
241	....	Slope...	220	25.2	19.3	.....do...............	Tiled.
242	....	...do....	215	20.2	14.3	....	
243	....	...do....	215	14.5	13.0	Chain pump........	
244	....	...do....	215	13.8	11.3	Windlass rig........	

[a] At the north side of the house on the west side of the road and opposite well No. 95.
[b] These wells abandoned on account of suspected contamination from the filter beds of the Bristol sewage-disposal plant.

Dug wells ending in stratified drift in Bristol—Continued.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
245	....	Slope...	220	18.0	16.4	Windlass rig........	Unfailing; abandoned.
246	....	...do....	260	19.8	17.3	.....do..............	Tiled; abandoned.
247	....	...do....	255	16.1	13.6	House pump........	Tiled.
248	....	...do....	260	16.9	14.0	.....do..............	Do.
249	....	...do....	265	19.4	18.1	Windlass rig........	Abandoned.
250	....	...do....	290	24.6	18.3	Chain pump........	
253	....	Hilltop..	270	17	....	...do..............	Fails; tiled; abandoned.
254	....	Slope...	265	15	....	....	Fails.
255	....	...do....	240	26.0	22.5	Windlass rig........	Abandoned.
256	....	...do....	260	23.4	22.2	.....do..............	Fails.
257	....	...do....	250	28.9	25.0	....	
258	....	...do....	230	23.5	21.2	Windlass rig........	Tiled.
259	....	...do....	220	15.3	13.6	Chain pump........	Abandoned.
261	....	...do....	270	17.9	15.9	....	Do.
262	....	...do....	265	17.3	13.0	Windlass rig........	
263	....	...do....	270	21.0	14.0	.....do..............	
270	....	...do....	225	16.7	12.1	Chain pump........	
271	....	...do....	225	19.9	16.8	.....do..............	
272	....	...do....	225	22.8	19.1	....	Tiled; abandoned.
273	....	...do....	220	24.9	21.2	Windlass rig........	Abandoned.
274	....	...do....	230	43.9	42.3	.....do..............	Do.
275	....	...do....	225	22.2	19.2	.....do..............	Do.
276	....	...do....	220	18.4	12.2	....	
277	....	...do....	250	30.8	29.4	Windlass rig........	
278	....	...do....	245	25.0	22.9	Chain pump........	
281	....	...do....	220	10.1	7.9	.....do..............	Do.
282	....	.Plain...	205	9.5	8.5	.....do..............	Do.
283	....	...do....	210	10.5	7.7	.....do..............	
284	....	...do....	200	10.1	7.9	.....do..............	Do.
285	....	...do....	205	7.4	6.3	....	Do.
286	....	...do....	200	7.9	5.7	Chain pump........	
287	....	...do....	195	6.6	5.5	Windlass rig........	Unfailing.
288	....	...do....	195	8.2	6.3	House pump........	Tiled.
289	....	...do....	195	5.2	4.3	....	Abandoned.
294	....	...do....	245	27.8	27.0	Two-bucket rig.....	
295	....	...do....	250	20.4	17.1	Pitcher pump.......	Tiled.
296	....	...do....	245	29.5	23.9	House pump........	Tiled; abandoned.
297	....	...do....	250	24.3	22.3	Windlass rig........	
299	....	...do....	245	22.4	21.9	House pump........	
300	....	...do....	250	21.3	20.2	Deep-well pump....	
301	....	...do....	250	24.7	22.3	House pump........	Tiled; unfailing.
302	....	...do....	250	23.6	21.6	.....do..............	Tiled.
304	....	...do....	255	10	7	Gasoline engine....	(*h*).

h This well was dug through the following section: 8 inches loam, 2 feet clean sand, 2 feet clean gravel, 5 feet sand. It is about 8 feet in diameter and is pumped by a gasoline-driven centrifugal pump. Water used for irrigating.

Driven wells in Bristol.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Remarks.
			Feet.	*Feet.*	*Feet.*	
70	Ingraham Clock Co..............	Narrow plain.	340	25–30	(*a*)	
211	....	Plain..........	225	35	....	Fails.
212	....	.....do.........	245	30	25	
298	....	.....do.........	250	30	....	(*b*).

a 8 or 10 wells, abundant water found just above bedrock. Abandoned because of hardness of the water.
b A 25-foot dug well deepened with a 5-foot drive pipe.

Drilled wells in Bristol.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Depth to water.	Diameter of well.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*In.*	*Gals.*		
13	S. N. Minor....	Hilltop..	810	....	62	....	8	$2\frac{1}{2}$	Granite gneiss	(a).
62	R. W. Williams	Flat hill-top.	445	90	26	30	6	$2\frac{1}{2}$	.... do........	Pneumatic system; for assay see p. 94.
69	Sessions Foundry Co.	Plain....	375	156	30–40	4	......	85–90	.....do........	(b).
71	New Departure Manufacturing Co.	...do.....	320	315	50	12	8–6	20	.....do........	
290	M. T. McCormick.	Slope....	255	52	4	26	......	1	Sandstone....	For assay see p. 94.[c]
291	J. Tegnon......	...do.....	265	60	20	....	10	5	.....do........	
293	F. A. Peck.....	...do.....	255	75	8	....	6	......	.....do........	For assay see p. 94.

[a] Not completed when visited; then 123 feet deep; water was obtained from a fissure at about 100 feet depth.
[b] This well will flow 7 gallons a minute through a pipe to the level of a brook near by, but pumping increases yield. Used for boilers, etc.
[c] Water enters from three fissures.

Springs in Bristol.

No. on Pl. III or fig. 20.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	°*F.*	*Gals.*	
14	....	Slope..........	680	52	....	
21	....	Swale..........	700	....	....	Unfailing.
30	E. J. Fitzpatrick...	Foot of slope..	430	49	100 (?)	Piped to bottling works; for analysis see p. 94.
39	....	Valley........	405	48	....	Used by C. E. Perkins for bottling.
42	....	......do.........	605	54	....	Concrete basin; unfailing.
68	....	Slope..........	330	53	....	
74	J. L. Willcox.......	......do.........	380	57	....	Piped to house; unfailing.
75	....	......do.........	310	53	....	Piped to house; unfailing; basin blasted out of granite ledge; well 70 years old.
80	....	......do.........	260	57	....	Issues from a ledge.
81	....	......do.........	280	55	(a)	Reservoir 9 feet square by $4\frac{1}{2}$ feet deep supplies 2 houses; issues from a ledge.
87	....	Foot of terrace.	255	54	20	Unfailing.
99	....	Slope..........	310	51	....	Issues from cracks in rock; unfailing.
107	....	......do.........	310	60	....	Spring house.
121	....	Foot of slope..	270	54	15	
156	....	Slope..........	660	....	....	Supplies a laundry and a horse trough.
168	....	......do.........	375	....	....	Piped to house.
175	A. S. Pons.........	......do.........	370	54	(a)	Piped to house; unfailing; for assay see p. 94.
303	O. H. Robertson...	......do.........	300	60	....	Rubble and concrete basin 6 by 10 feet; frame coop; piped to house.

[a] Fills a $\frac{3}{4}$-inch pipe.

QUALITY OF GROUND WATER.

Below are given two analyses and four assays of samples of ground water collected in Bristol. These waters are low in total solids and soft and are suitable for most domestic and industrial purposes. They would form little scale in boilers and would not cause foaming.

Chemical composition and classification of ground waters in Bristol.

[Parts per million; samples collected Nov. 17, 1915; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding numbers on Pl. III or fig. 20; see also records corresponding in number, pp. 88–93.]

	Analyses.[a]		Assays.[b]			
	[c]30	95	62	175	290	[d]293
Silica (SiO_2)	18	14				
Iron (Fe)	[e].31	.05	0.50	Trace.	Trace.	Trace.
Calcium (Ca)	4.8	13				
Magnesium (Mg)	1.1	3.8				
Sodium and potassium (Na+K)[f]	[g]1.5	5.6	2	9	14	5
Carbonate radicle (CO_3)	7.6	.0	0	0	0	0
Bicarbonate radicle (HCO_3)		44	48	66	46	66
Sulphate radicle (SO_4)	2.1	7.4	Trace.	Trace.	10	Trace.
Chloride radicle (Cl)	1.5	7.0	5	9	17	5
Nitrate radicle (NO_3)		8.0				
Total dissolved solids	[h]37	76	[f]64	[f]86	[f]97	[f]80
Total hardness as $CaCO_3$	[f]16	[f]48	43	49	45	51
Scale-forming constituents [f]	34	59	60	65	60	65
Foaming constituents [f]	5	15	([i])	20	40	10
Chemical character	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion [j]	(?)	(?)	(?)	N	(?)	N
Quality for boiler use	Good.	Good.	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Sample collected Dec. 12, 1895; analyzed by R. H. Chittenden; recalculated from hypothetical combinations in grains per U. S. gallon to ionic form in parts per million.
[d] Sample collected Nov. 19, 1915.
[e] $Fe_2O_3+Al_2O_3$.
[f] Computed.
[g] Determined.
[h] By summation.
[i] Less than 10 parts per million.
[j] Based on computed value; N=noncorrosive; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

Bristol and Forestville are supplied with water by the works of the Bristol Board of Water Commissioners, which in 1914 took over the property of the Bristol Water Co., a private corporation organized in 1884. Water is delivered by gravity from reservoir No. 1, near the west boundary of the town half a mile north of Terryville station. The pressure ranges from 30 to 130 pounds to the square inch. The reservoir was constructed by damming a stream, floods 28.12 acres, and has a capacity of 57,000,000 gallons. A 500,000-gallon concrete reservoir and a 180,000-gallon steel standpipe on Federal Hill, northeast of Bristol, are connected with the mains of Bristol for supplying Forestville. Regulating valves half a mile east reduce the pressure for the mains in Forestville. Reservoir No. 3, which floods 4¼ acres about 1½ miles northwest of reservoir No. 1 and has a capacity of

800,000,000 gallons, diverts water from Poland River into mains which carry it to reservoir No. 1. Reservoir No. 2 is on a small tributary which enters Poland River farther upstream, about a mile north of the Plymouth-Harwinton town line, has a capacity of 107,000,000 gallons and floods 11 acres. Reservoir No. 4 was made by enlarging Gridley Pond on Poland River a mile north of reservoir No. 2. The dam is of the concrete core-wall type and floods 42½ acres with 249,000,000 gallons. The water from reservoirs Nos. 2 and 4 is carried to No. 3 in an open brook. The area of the drainage basins that supply reservoirs Nos. 2, 3, and 4 is about 7½ square miles. According to Mr. A. W. Jepson, superintendent of waterworks, there were in 1914 about 41 miles of mains, 133 hydrants, and 1,961 service taps, and the consumption was 1,236,000 gallons a day. When the waterworks were taken over by the city it was estimated that with an increase of population proportional to that from 1900 to 1910 the supply would be adequate for 25 years. It is now about double the consumption.[41]

At Polkville there is a small communal water supply in the expense and benefits of which eight families share. Water is conducted from the flume below the mill pond to the west by means of a 1¼-inch lead pipe. Branch pipes, of $\frac{5}{16}$-inch size, conduct water from the main line to cisterns in the houses, from which water is pumped. As the pipe is of lead it has been found impracticable to carry water to the upper stories. Mr. George S. Osborn, who supplied the information, estimates the annual expense of maintenance at not over $5.

BURLINGTON.

AREA, POPULATION, AND INDUSTRIES.

Burlington is near the middle of the west boundary of Hartford County and lies west of Collinsville and Unionville. The east boundary in part follows Farmington River and in part approximates the margin of the highlands. Most of the west boundary is about on the divide between Naugatuck and Farmington rivers. The town has an area of 31 square miles, of which about three-fourths is wooded. There are settlements at Burlington, Whigville, and Burlington Station. At Burlington there is a church and general store. The New Hartford branch of the Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad follows the Burlington shore of Farmington River and has a station at Burlington Station. There are about 55 miles of road in the town, all of dirt construction. Many of the grades are high, and southeast of Burlington village the roads are very sandy, but elsewhere they are fairly good. The road from Burlington Station to Harwinton by way of Burlington is particularly well cared for.

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[41] Report of the city clerk, treasurer, etc., of the city of Bristol for the year ending Sept. 1, 1914, p. 80.

The territory of Burlington was taken from Bristol in 1806 and made a new town. Burlington has suffered less loss of population than many of the Connecticut highland towns. The population in 1910 was 1,319, which is equivalent to a population density of 43 per square mile. The maximum population, 1,467, was recorded in 1810, when the town was first counted separately. The population has been held by the factories at Collinsville and Unionville, which have given employment to the people.

Population of Burlington, 1810 to 1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1810	1,467	1850	1,161	1890	1,302
1820	1,360	1860	1,031	1900	1,218
1830	1,301	1870	1,319	1910	1,319
1840	1,201	1880	1,224		

[a] Connecticut Register and Manual, 1915, p. 652.

The principal industry of Burlington is agriculture, though many of the inhabitants work in the factories at Collinsville and Unionville.

SURFACE FEATURES.

Most of Burlington is a plateau 900 to 1,000 feet above sea level, above which rise a few higher hills and ridges. In the northwest corner of the town the plateau is fairly well preserved, but elsewhere it is deeply cut by valleys, and on the east the slopes descend steeply to Farmington River and to a small area of lowland in the southeast corner. The general highness of the town is due to the resistant character of its bedrocks, but it is more dissected than regions farther from the central lowland or from master streams. The topography has been modified by glaciation, the elevations having been worn down and the depressions filled in. Southeast of Burlington village there are extensive deposits of stratified drift, which seem to be similar to the stratified drift of the Pequabuck Valley in Bristol. (See p. 83.) The extent of these stratified-drift deposits, which form a little plain around Burlington village, is shown on Plate II. Back of the church at Burlington village is a fine kettle hole, 200 or 300 feet in diameter and 25 feet deep, formed by the melting away of a block of ice stranded in the stratified drift. A photograph of this kettle hole is reproduced in Plate V, *B* (p. 84).

The southern part of Burlington is drained by the waters of tributaries of Pequabuck River, the largest of which feeds the Whigville reservoir of the New Britain Board of Water Commissioners. The flow of this stream was estimated on July 15, 1915, at 1⅝ second-feet. Parallel to this stream and half a mile west is a second unnamed brook which on the same day flowed about 1 second-foot.

These streams unite 1½ miles south of the Bristol line to form North Branch of Pequabuck River. Marsh Pond Brook, in the southwest corner of Burlington, feeds into Marsh Pond, which discharges into the Pequabuck at Terryville. A quarter of a mile from the east boundary and a mile from the south boundary of Burlington is a pond whose outlet was estimated on July 14, 1915, to flow 1½ second-feet and ultimately discharges into Farmington River opposite Unionville. A mile below the pond the outlet is joined by a small stream which on the same day was estimated to discharge 0.75 second-foot.

Burlington Brook drains more of the town than any other stream and flows from the northwest corner across the town and joins the Farmington at Burlington Station. A careful estimate made half a mile above its mouth on July 20, 1915, indicated a flow of 11½ second-feet. The discharge of Punch Brook, which enters Burlington Brook a little above Burlington village, was estimated on July 8, 1915, at 2¾ second-feet. The next tributary upstream, entering Burlington Brook from the south, was estimated on the same day to flow nearly 2 second-feet.

Parallel to the north edge of the town is Phelps Brook, which 1½ miles west of its junction with Farmington River is joined from the south by Clear Brook. Gagings made for the Hartford Board of Water Commissioners[42] show a minimum flow for 1913 of about 1.2 second-feet, or 0.220 second-foot per square mile in the drainage basin (5.4 square miles), in the month of August. The maximum flow was 270 second-feet, or 52 second-feet per square mile, and was measured on October 26 and 27, soon after a fall of 6.6 inches of rain.

WATER-BEARING FORMATIONS.

There are four varieties of bedrock in Burlington—the Triassic red sandstone, Bristol granite gneiss, Hoosac schist, and Waterbury gneiss.

Sandstone.—The Triassic red sandstone is restricted to a triangular area of less than a square mile in the southeast corner of the town. The rock is the basal portion of the Triassic and is dominantly sandstone and conglomerate. No wells have been drilled into this formation in Burlington, but the probability of success is good. Wells in Farmington and Bristol that penetrate similar rocks obtain satisfactory supplies.

Gneiss and schist.—The Bristol granite gneiss, which underlies about a square mile in the valley in which Whigville is situated, is a grayish rock composed of quartz, feldspar, and black mica. Mashing has concentrated the mica in layers that alternate with

[42] Hartford Board of Water Commissioners Sixtieth Ann. Rept., p. 49, 1914.

layers containing little mica, so that the rock has a fairly pronounced gneissic structure. Water has not been obtained from this rock in Burlington, but undoubtedly it could be, for in the town of Bristol a number of drilled wells procure water from it.

The two remaining bedrock formations may be discussed together, for the Waterbury gneiss is believed to be a modification of the Hoosac schist, due to the injection of much pegmatite, amphibolite, and granite. These materials are normally found in the Hoosac schist, but they are so abundant in this neighborhood that they quite alter the character of the rock, and a separate classification seems justified.

The Hoosac schist is a typical mica schist composed of flakes of mica (both black and white), in many places altered to sericite and chlorite, and grains of quartz and feldspar. Mashing has recrystallized the original constituents of the rocks and parallelly oriented the mica flakes and concentrated them in bands along which they readily break. The forces to which this cleavability is due also made many larger joints and fissures, in which water undoubtedly circulates. This water, which is derived by percolation from the overlying mantle of soil, could undoubtedly be recovered by means of drilled wells, though no such development has yet been made in Burlington. In other towns (Hartland, Plymouth, Prospect, and Wolcott) there are drilled wells which obtain satisfactory supplies from this formation. The probability of obtaining water from the Waterbury gneiss is equally great, but drilling may be more expensive on account of the quartz and pegmatite veins, which make the operation difficult and slow.

Till.—The distribution of the two types of glacial drift is shown on Plate II. Till is the material formed by the plowing and scraping of the glacier and consists of a thoroughly mixed mass of débris of all kinds of material in fragments which range in size from rock flour to big boulders. It may be considered a matrix of sand, silt, clay, and rock flour in which boulders, cobbles, and pebbles are embedded. Between the smaller particles are interstices that are capable of absorbing rain water, of storing it, and of giving it out again to dug wells. Wells dug in till will yield moderate and fairly reliable supplies of water unless they are unfavorably situated. Forty-eight wells dug in till were measured in Burlington; the average depth of water was 12.6 feet, though the depth ranged from 2 feet in well No. 31 (see Pl. III) to 37.6 feet in well No. 63. The maximum fluctuation of the water table was in well No. 32, which fails, though it had 14.6 feet of water when it was measured (July 20, 1915). Well No. 61, which is said to be nonfailing, has the least fluctuation, for although the fore part of the month had been rather rainy it had only

1.6 feet of water on July 15, 1915. About half of these wells are not deep enough to reach below the lowest level to which the ground-water table sinks, and they fail in prolonged droughts. Probably many of them could be deepened so that their supplies would be made permanent. It is better to abandon a rock-bottomed well that fails and to dig another well in a more favorable place or to drill a well than to deepen by blasting.

There are a number of springs in Burlington which derive their water from till. Most of these are on slopes above the houses to which they appertain, and their water is piped in by gravity.

Stratified drift.—Stratified drift is a water-laid deposit formed by the reworking of the materials of the till. The various sizes have been sorted and laid in separate beds and lenses. Because of the elimination of the fine particles from the interstices of the larger particles the porosity of stratified drift is greater than that of till, so it absorbs

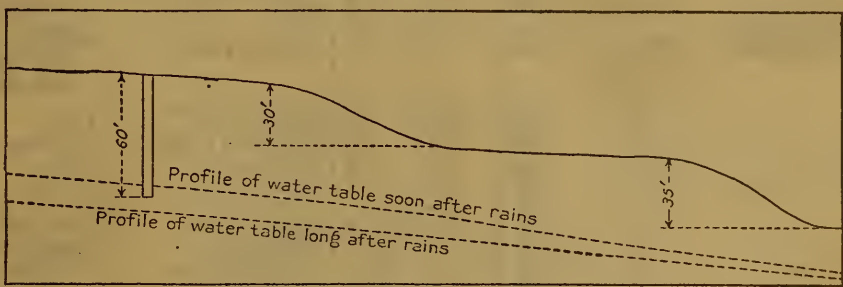

FIGURE 21.—Relations at well No. 29, Burlington.

and transmits water more readily, but it will not store water as long if its topographic situation is unfavorable. The 20 wells dug in stratified drift that were measured in Burlington show greater reliability than the wells in till, as only 5 of them fail. The depth to water in them averages 19.1 feet and ranges from 7.9 feet in well No. 22 (see Pl. III) to 60 feet in well No. 29; the greatest fluctuation of the water table was 5 feet in well No. 29, and the least 1.4 feet in well No. 32.

Well No. 29 shows the effect of a disadvantageous topographic situation. It is about 100 feet back from the brink of a terrace 30 feet high, below which is another terrace 200 or 300 feet wide and about 35 feet high. After heavy rains the water which falls on the flat area back of the well soaks through the ground and supplies the well. After some time it passes completely by and the well fails. The well seems paradoxical in its behavior, for often it fails during a rainy spell because the last wave of ground water has passed and the new one has not yet reached it. Similarly during a dry season the lagging water from the last rains may reach the well when other wells are failing. The relations in this well are shown in figure 21.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Burlington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1		Slope	930	13.8	10.8	Sweep rig	Abandoned.
2		do	925	15.2	9.1	Chain pump	Unfailing.
3		do	900	18.4	8.4	do	Do.
4		Valley	985	15.0	10.5	do	Do.
5		Slope	935	13.0	4.9	Wheel and axle ring.	Fails.
6		do	1,055	16.6	6.7	Pitcher pump	Unfailing.
8		Plain	905	25.6	17.1	Chain pump	Do.
9		do	890	18.4	13.6	Windlass rig	
10		do	880	29.4	24.5	do	Do.
12		Slope	970	7.6	5.2	Deep-well pump	Do.
13		do	1,080	13.7	9.4		Fails.
14		do	790	21.6	16.3	Windlass rig	Unfailing.
16		do	790	20.3	17.8	Two-bucket rig and house pump.	Fails.
18		do	910	15.8	11.0	Windlass rig	
19	L. F. Turner	Plain	850	38.3	20.6	(a)	Abandoned; unfailing.
23	G. N. Merrill	Slope	815	17.0	12.8	Chain pump	Unfailing; at house; rock bottom; for analysis see p. 102.
31		do	700	4.5	2.0	Gravity system	
32		do	630	16.9	2.3	Windlass rig	Fails.
33		do	660	10.0	8.0	Deep-well pump	Unfailing.
34		Valley	680	17.2	14.8	Windlass rig	Fails.
37	Charles Nilsen	Slope	845	9.2	4.2	Chain pump	Do.
41		do	480	28.5		Windlass rig	Do.
42		do	430	17.9	15.4	Pitcher pump	Fails; rock bottom.
43		do	395	25.3	24.5	Chain pump	Fails; tiled.
44		do	420	27.5	21.7	Two-bucket rig	Unfailing.
45		do	430	32.0	13.5	Chain pump	Do.
46		do	540	12.1	8.1	do	Do.
47		do	655	17.9	14.1	do	Do.
48		do	590	18.8	14.0	do	Fails.
49		do	585	13.8	6.2	do	Do.
50		do	1,050	27.0	19.2	Windlass rig	Do.[b]
51		Plateau	935	18.5	7.1	do	Unfailing.
52		Slope	720	39.1	8.1		Do.
54		do	740	13	9	Deep-well pump	Fails.
55		do	720	20.5	12.5	House pump	Unfailing.
56		do	930	20.2	12.2	(a)	Fails.
57		do	840	12.3	6.0	Windlass rig	
60		do	510	38.7	32.6	do	Unfailing; tiled.
61		do	410	18.6	17.0	House pump	Unfailing.
62		do	480	20.4	19.0	Chain pump	Fails.
63		do	530	40.1	37.2	Two-bucket rig	Abandoned.
64		do	460	6	4	House pump	Unfailing.
65		Plain	415	10.7	8.0		Unfailing; abandoned.
66		do	400	17.8	16.0		Do.
68		Swale	470	20.1	15.9	Windlass rig	Fails.
69		Slope	460	17.0	12.8	Sweep rig	Do.
70		do	565	20.3	10.9	do	
71		do	550	9.4	5.3	Chain pump	Do.
72		do	500	14.1	3.8	do	Unfailing.
74		Knoll	305	24.4	20.8	do	

[a] No rig.
[b] Rock bottom; great fluctuation; response of water level 6 to 8 weeks behind rains.

Dug wells ending in stratified drift in Burlington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
7	....	Slope....	780	25.6	11.3	Windlass........	Unfailing.
11	....	...do.....	945	22.9	21.1	.....do........	Do.
20	....	...do.....	800	17.2	9.9	.....do........	Do.
21	....	Plain ...	800	27.8	24.0	....	Abandoned.
22	G. N. Merrill....	Slope....	810	11.2	7.9	Chain pump........	Fails. At barn.
24	....	Plain....	820	15.0	12.0	Windlass........	Unfailing.
25	....	Slope....	815	16.0	11.5	.....do........	Fails.
27	....	...do.....	815	18.5	14.2	.....do........	Unfailing.
28	L. F. Turner....	Plain....	820	35.0	31.7	Two-bucket rig......	Fails.
29	F. H. Stone.....	Edge of terrace.	810	65.0	60.0	.....do........	Fails; for assay see p. 102.
30	....	Plain....	790	60.0	55.0	....	Fails.
38	....	Slope....	500	15.9	14.5	Sweep rig........	Unfailing.
39	....	...do.....	650	16.0	14.2	Windlass........	Do.
40	....	...do.....	455	13.2	8.4	....	Partly filled in.
53	....	Plain....	710	14.3	8.2	Deep-well pump	Unfailing.
58	....	...do.....	705	21.3	16.2	Windlass........	Do.
59	....	...do.....	710	19.8	15.9	.....do........	Do.
67	....	...do.....	375	15.1	11.0	House pump........	Do.
73	E. W. Hart......	...do.....	280	20.2	15.3	Windlass........	Unfailing; for assay see p. 102.

Springs in Burlington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*°F.*	*Gallons.*	
15	E. S. Gillette........	Slope........	900	48	2.5	Piped to house and barn; unfailing; for analysis see p. 102.
17	E. H. Hinman........	.....do........	890	51	....	Piped to house; for assay see p. 102.[a]
26	....	.....do........	730	48	5	Piped to house.
35	J. W. Keeler........	Swale........	720	....	....	Piped to house; unfailing.
36	Chas. Nilsen........	.....do........	860	49	6	Unfailing.

[a] Reservoir blasted in rock ledge; supplied from one principal seam and three lesser ones.

QUALITY OF GROUND WATER.

The results of two analyses and three assays of samples of ground water collected in Burlington are given in the subjoined table. The waters are soft, low in mineral content, and of calcium-carbonate type. They are suitable for all common uses and good for use in boilers.

Chemical composition and classification of ground waters in Burlington.

[Parts per million; samples collected Nov. 23, 1915; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 100–101.]

	Analyses.[a]		Assays.[b]		
	15	23	17	29	[c]73
Silica (SiO_2)	9.5	15			
Iron (Fe)	.75	.04	0.20	Trace.	Trace.
Calcium (Ca)	4.0	6.5			
Magnesium (Mg)	1.9	1.8			
Sodium and potassium (Na+K) [d]	2.1	4.6	Trace.	Trace.	4
Carbonate radicle (CO_3)	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	17	27	19	24	46
Sulphate radicle (SO_4)	4.1	6.9	Trace.	Trace.	Trace.
Chloride radicle (Cl)	3.0	3.0	3	7	8
Nitrate radicle (NO_3)	Trace.	.0			
Total dissolved solids	36	50	[d]36	[d]47	[d]68
Total hardness as $CaCO_3$	[d]18	[d]24	21	31	40
Scale-forming constituents [d]	24	37	35	45	55
Foaming constituents [d]	6	12	Trace.	Trace.	10
Chemical character	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion [e]	(?)	(?)	(?)	(?)	(?)
Quality for boiler use	Good.	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Sample collected Nov. 17, 1915.
[d] Computed.
[e] Based on computed value; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

Burlington has no public water supply, though 20 families near Collinsville are supplied by the Collinsville Water Co. Some of the drainage basins of the town have been developed by Hartford and New Britain. A 60,000,000-gallon reservoir at Whigville provides water for the high-pressure system of New Britain. Surveys have been made for the board of water commissioners of New Britain for an additional supply in the upper part of the drainage basin of Burlington Brook. Part of the new 8,500,000,000-gallon Nepaug reservoir, which is now under construction for the board of water commissioners of Hartford, is in Burlington and will use the water of Phelps and Clear brooks. If it becomes necessary to develop a water supply for Burlington the problem will be difficult, as most of the possible reservoir sites are now occupied. The best way of utilizing the ground-water supply seems to be the indirect method. Reservoirs of the streams which enter Burlington Brook from the south would receive continued contributions of ground water from the bodies of stratified drift above.

CANTON.

AREA, POPULATION, AND INDUSTRIES.

Canton is near the middle of the western boundary of Hartford County, about 10 miles south of the Massachusetts line, and is on the eastern edge of the western highland of Connecticut. To the

west are New Hartford and Barkhamsted, and to the south is Avon. In addition to Collinsville, the principal settlement, which is in the southern part of the town, there are small settlements at Canton Center, North Canton, Canton, or Canton Street, as it is locally called, and Cherry Brook. There are post offices at all these settlements except Cherry Brook. The town has an area of about 31 square miles, of which two-thirds is wooded. The State trunk-line highway of bituminous macadam between Avon and New Hartford passes through Canton and Cherry Brook, and other macadam roads join Collinsville to Canton and to Cherry Brook. In addition to these roads, which have a combined length of 9 miles, there are about 90 miles of dirt roads. The road from Cherry Brook to Canton Center and North Canton is good, as it has been extensively graveled and graded. The New Hartford branch of the Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad crosses the southwest corner of the town in Farmington River valley and has a station at Collinsville. The Central New England Railway crosses the southern part of the town and has stations at Canton, High Street, Collinsville, and Cherry Brook. The Collinsville station is at the end of a spur track three-quarters of a mile long which joins the main line at High Street. A stage with a star postal contract carries the mail daily between Cherry Brook, Canton Center, and North Canton.

Canton had a population of 2,732 in 1910. In 1806 the territory was taken from Simsbury and incorporated as a separate town. The population increased rather steadily up to 1870; then it fell off for one decade but again increased so that the last census return was the greatest. It is probable that the population will be retained or be increased in the future.

Population of Canton, 1810 to 1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1810	1,374	1850	1,986	1890	2,500
1820	1,322	1860	2,373	1900	2,678
1830	1,437	1870	2,639	1910	2,731
1840	1,736	1880	2,301		

[a] Connecticut Register and Manual, 1915, p. 652.

The principal industries of Canton are farming and the manufacture at Collinsville of heavy edge tools, such as axes, adzes, plows, and machetes. The manufacturing has been the means of maintaining and increasing the population and has been made possible by the water power provided by Farmington River and the excellent transportation route down the valley. The farmers raise general crops principally, but there is some tobacco growing and dairying.

SURFACE FEATURES.

Most of Canton is a deeply dissected upland and is somewhat rugged. The east boundary follows the general trend of an almost continuous trap ridge, just west of which is a series of north-south valleys that separate the trap ridge from the upland. The southeast corner of the town is a lowland 1½ miles wide, above which rises Mount Horr and Huckleberry Hill. Rattlesnake Hill separates this lowland from the valley of Cherry Brook, which drains most of the upland. The highest point in the town is at the north end of Ratlum Mountain and is 1,200 feet above sea level. The lowest point, on Farmington River near Collinsville, is 300 feet above sea level.

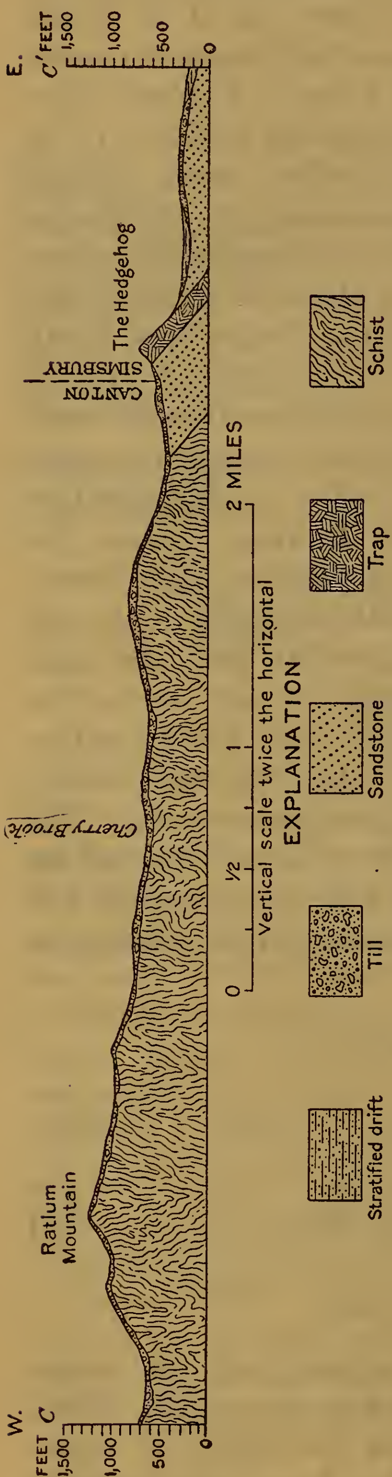

FIGURE 22.—Section across Canton and into Simsbury.

The broad valley between Mount Horr and Huckleberry Hill drains in both directions from a very low divide near Canton. It is possible that the Farmington formerly flowed through this valley and then southward along Roaring Brook valley, or perhaps eastward on the north side of Pond Ledge Hill. At its west end the floor of this valley merges with the flood plain and terraces of the Farmington Valley, which in turn merges with the flood plain and terraces of Cherry Brook. Between Cherry Brook and the New Hartford town line the terraces on the east bank of Farmington River widen out to about half a mile. Formerly the Farmington flowed near the east side of this terrace area, but in glacial time it was diverted into a new channel at Satans Kingdom, which it has cut down to make a narrow gorge with walls about 100 feet high.

Figure 22 is a structure section across Canton and Simsbury (line *C–C',* Pl. II) and shows the various topographic elements. At the east boundary of Canton is the trap ridge, which includes a couple of peaks with special names descriptive of their form—the Sugarloaf and the Hedgehog. West of the ridge is the sandstone valley, and farther west the dissected upland.

Most of the streams in Canton are tributary to the southward-flowing reach of Farmington River, though the northeastern part of the town is drained by streams that cross Simsbury and enter the northward-flowing reach. One of these, Stratton Brook, had a discharge of about a third of a second-foot on September 18, 1915.

The southeast corner of Canton is drained by the headwaters of Roaring Brook, which crosses Avon and joins the Farmington at Unionville. A float measurement of this stream made half a mile above the State road joining Avon and Canton on July 9, 1915, showed a flow of about 3.5 second-feet.

Cherry Brook is the largest stream in the town east of Farmington River. It flows from a point a little north of the northwest corner of the town through North Canton and Canton Center and joins the Farmington between Satans Kingdom and Collinsville. A float measurement of this stream on September 15, 1915, a mile south of North Canton showed a flow of 1.4 second-feet. The next day a measurement near Canton Center gave a flow of 1.7 second-feet.

Nepaug River drains that part of the town southwest of Farmington River.

WATER-BEARING FORMATIONS.

In Canton there are four varieties of bedrock—the Hoosac schist, Collinsville granite gneiss, and sandstone and trap of Triassic age.

Schist and gneiss.—The oldest of the formations is the Hoosac schist, which underlies the whole town except a strip along the east edge and the southern part of the town east of the Farmington. This rock is composed chiefly of flakes of light and dark mica, which give it its silvery gray color and its fissile structure, and granules of quartz. The rock is believed to have been originally a series of shales and clayey sandstones which have acquired their present character through metamorphism. The forces which produced these mineral and textural changes have also fissured the rock extensively. The fissure system is very intricate, and the openings are connected with one another in a very complicated way. Many of the fissures reach the surface of the rock, and water seeps into them from the overlying soil. No wells which obtain water from this formation were found in Canton, but elsewhere drilled wells procure satisfactory supplies from its fissures.

Mount Horr and Huckleberry Hill and the valley west of Mount Horr are underlain by the granite gneiss, which is composed essentially of grains of feldspar and quartz with flakes of mica, together with subordinate amounts of garnet and hornblende. Two varieties are recognized, the difference between them being due to difference in the amount of mica. The mica has been concentrated in certain bands by metamorphism, and gives the rock its gneissic texture. The whole mass is cut by numerous dikes and veins of unmetamorphosed granite and pegmatite. Like the schist, the granite is fissured, but probably not so extensively. Although no wells that draw

from this rock were found, there is sufficient probability that a drill hole would cut one or more water-bearing fissures in it within a reasonable distance to justify drilling.

Trap rock.—The ridges along the east boundary of Canton are capped by trap rock, which underlies the eastern slopes and forms cliffs at the top of the western slope in many places. The conditions for water in the trap are about the same as in the granite, as the joints are of about the same size and abundance. However, the trap is difficult to drill, as it is very tough, and because of its resistance to weathering it stands up as high ridges, a disadvantageous position. Most water falling on the ridges flows away instead of soaking in, so that the supply of water to fissures in trap is both small and uncertain.

Sandstone.—Underlying the trap ridges and the valleys west of them is red sandstone, which is, however, exposed only in a few scattered outcrops. The sandstones were deposited as a series of sand, silt, and gravel beds, but the grains have been cemented by a mixture of iron oxide and clay with a little lime carbonate, so that a firm rock resulted. The beds were originally horizontal, but they have been tilted so that they dip 15° or 20° to the east, and have also been broken into blocks. They were extensively jointed and fractured in the process of tilting. Mr. Case's well (No. 55, Pl. III) was originally a dug well reaching bedrock at a depth of 29 feet. As it used to fail Mr. Case had a hole drilled in the bottom and very fortunately cut a water-bearing fissure in the sandstones after drilling only 14 feet. It is probable that to improve any well in the sandstone area deeper drilling would be necessary.

Till.—Till, which mantles most of the town except the areas of rock outcrop, is a product of direct glacial action. The ice sheet that moved in a southerly direction across New England broke off and ground off a great deal of the bedrock, and this material was carried along and ground up and mixed together. Finally it was deposited as a heterogeneous, compact, and firm mixture of all sorts of materials in fragments of a great variety of sizes from fine rock flour and clay up to large boulders. The till is moderately porous and capable of holding some ground water. In places it was partly washed and stratified by the water that flowed under the ice. A lens of such material, if penetrated by a dug well, will generally yield an abundant and reliable supply of water. Fifty-seven wells dug in till were measured in Canton, and of these 19 were said to fail. The depth to water in the 57 wells ranged from 0.8 foot in well No. 51 (see Pl. III) to 26.4 feet in well No. 59; the average was 10.5 feet. The greatest fluctuation of level noted was in well No. 36, which fails, although it had 14.2 feet of water when it was measured in September, 1915.

A number of houses along Cherry Brook and in other parts of the town are supplied by gravity from springs in till.

Stratified drift.—Stratified drift is the surface material along parts of Cherry Brook and in the valleys of Roaring Brook and Farmington River where it forms terraces and flood plains.

The stratified drift of Cherry Brook is the excess débris carried by the small, swift tributaries which the slower main stream was unable to transport. The deposits along the Farmington and along Roaring Brook are partly similar and partly the waste washed out from the front of the ice sheet as it receded from this region. The stratified drift is composed of beds and interlocking lenses of well-washed and highly porous silt, sand, and gravel. Wells in the stratified drift, unless situated on steep slopes from which the water may seep away, yield supplies which are abundant and reliable. Twenty-one wells dug in till were measured in Canton. None of these was said to fail, but the reliability of two was not ascertained. The depth to the water level ranged from 5.4 feet in well No. 80 (see Pl. III) to 28.8 feet in well No. 88; the average was 13 feet.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Canton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1	....	Slope...	870	12.6	7.7	Windlass rig........	Fails.
2	....	...do....	940	16.3	11.2	.....do..........	Do.
3	....	...do....	930	15.1	5.5	.....do..........	Do.
4	....	...do....	920	14.5	8.1	.....do..........	
5	....	...do....	750	10.0	8.5	(a)	Do.
7	....	...do....	700	11.6	9.6	Sweep rig..........	Do.
8	....	...do....	630	10.4	6.4	(a)	Abandoned.
9	....	...do....	750	16.5	8.0	Chain pump........	Fails; rock bottom.
10	....	...do....	610	20.8	12.9	.....do..........	
15	....	...do....	510	16.0	10.7	Windlass rig........	Fails.
16	....	...do....	525	12.8	10.3	.....do..........	Unfailing.
18	....	...do....	625	19.9	12.8	Siphon..........	(b).
21	....	...do....	995	18.0	11.4	Windlass rig........	Unfailing.
22	....	...do....	730	20.7	17.5	.....do..........	
23	....	...do....	700	12.9	5.7	House pump........	Do.
24	....	...do....	855	9.4	6.8	(a)	Fails.
25	....	...do....	800	15.1	9.9	Windlass rig........	Unfailing.
27	....	...do....	740	11.2	5.6	Pitcher pump and house pump.	Do.
29	Albert Bond....	...do....	710	19.5	11.8	Deep-well pump....	Unfailing: for assay see p. 109.
30	....	...do....	665	11.5	5.2	Chain pump........	
31	N. Canton P. O.	...do....	680	14.5	7.0	Windlass rig and house pump.	Unfailing.
32	A. W. Sweeton..	Hilltop..	665	12.8	8.1	Windlass rig........	Unfailing: for assay see p. 109.
33	....	...do....	650	16.4	9.9	Chain pump........	Unfailing.
34	....	Slope...	670	20.4	12.8	.....do..........	Do.
35	....	...do....	675	10.4	6.9	Windlass rig........	Fails; rock bottom.
36	....	...do....	810	23.0	8.8	.....do..........	Do.
37	....	...do....	560	15.0	11.2	No rig..........	House abandoned.
38	....	...do....	410	22.0	17.1	Chain pump........	Unfailing.
39	S. W. Lamphier.	...do....	420	22.8	20.9	.....do..........	Do.
41	W. S. Humphrey.	Slope...	405	17.3	9.0	Chain pump........	Unfailing; for assay see p. 109.
42	....	Hilltop..	575	27.8	12.8	Windlass rig........	Unfailing.[c]
43	....	Slope...	570	24.4	8.5	Deep-well pump....	Do.
44	H. P. Foote.....	...do....	460	18.2	11.5	Windlass and pulley rig.	Fails.[d]
46	Case..........	Plain...	440	19.0	12.4	Windlass rig........	Unfailing.

[a] No rig.
[b] High point of siphon is 13 feet above water level and 25 feet above house.
[c] Depth to water varies from 4 to 24 feet; temperature 53° F.
[d] Well at least 125 years old.

Dug wells ending in till in Canton—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
48		Slope	455	19.7	16.0	Chain pump	
50		...do	700	15.4	8.5	Windlass rig	Unfailing.
51		...do	710	10.1	0.8	Chain pump	Fails.
52		...do	635	24.2	14.5	Windlass rig	Do.
53		...do	565	6.0	3.6	(a)	Do.
54		...do	505	16.7	11.8	Windlass rig	Do.
56		...do	360	14.4	9.6	...do	Unfailing.
57		...do	485	16.0	11.5	...do	Do.
58		...do	610	15.7	10.8	...do	Fails.
59		...do	625	33.0	26.4	Two-bucket rig	Unfailing.
61		...do	425	10.5	8.6	Windlass rig	Fails.
62		...do	600	11.4	8.3	...do	Unfailing.
63		Hilltop	760	30.1	9.4	Chain pump	Do.
64		Slope	750	20.9	8.1	Pitcher pump	Do.
65		...do	875	16.9	11.9	House pump	Fails.
66		Plateau	900	10.4	6.6		Do.
67		Slope	440	9.8	6.3	Chain pump	Unfailing.
70		...do	350	19.0	16.0	Deep-well pump and house pump.	Do.
74		...do	400	13.0	7.3	...do	Do.
75		...do	400	15.0	10.1	...do	Do.
76		...do	350	28.8	25.3	...do	Fails; abandoned.
79		...do	367	14.8	9.1	Chain pump	
89		Hilltop	360	19.4	17.2	One-bucket rig	

[a] No rig.

Dug wells ending in stratified drift in Canton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
11		Slope	360	11.4	7.7	Gravity system	Unfailing.
12		Terrace	390	22.8	18.8	Chain pump	Do.
13		...do	390	10.3	8.4	House pump	Do.
14	John Allen	Slope	395	12.6	8.7	Windlass	Unfailing; for analysis see p. 109.
40		Plain	395	18.6	16.4	...do	Unfailing.
45		...do	420	11.3	9.0	Chain pump	
68		...do	320	18.4	11.5	...do	
69		...do	320	13.9	10.7	Windlass	Do.
71		...do	325	12.7	9.6	House pump	Do.
72		...do	310	11.0	7.4	Two house pumps	Do.
73		...do	315	19.3	17.6	Windlass	Do.
77		Slope	350	23.2	18.8	Chain pump	Unfailing; abandoned.
78		Plain	325	9.4	6.7	Air-pressure system.	Unfailing.
80		...do	335	8.3	5.4	Chain pump	Do.
81		...do	340	9.2	6.8	Chain pump and power-driven cylinder pump.	Do.
82		...do	335	14.3	12.2	Two house pumps	Do.
83		...do	335	20.0	17.7	Windlass	Do.
85		...do	335	16.0	9.0	Pitcher pump	Do.
86		...do	325	19.4	9.3	Windlass	Do.
87		...do	325		32.0(?)	Electric pump	Do.[a]
88		...do	325	36.2	28.8	Deep-well pump	Do.

[a] 400 to 500 gallons used a day.

Drilled well in Canton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*	
55	Case	Slope	370	43	29	6		Gneiss.

Springs in Canton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*° F.*	*Gallons.*	
6	....	Slope..........	925	53	....	Unfailing.
17	....	......do..........	625	56	½	At roadside.
19	....	......do..........	690	54	1	Unfailing.
20	....	......do..........	1,065	58	....	Fails.
26	Chas. B. Quick..........	......do..........	840	56	¾	Unfailing; for analysis see p. 109.
47	Case..........	......do..........	530	58	....	
49	....	Swale..........	580	54	....	Unfailing.
60	....	Slope..........	500	58	....	Fails.
84	Gra-Rock Spring Water Co.	Foot of slope..	325	47.5	(a)	Unfailing; for analysis see p. 109.

[a] Spring walled with concrete. Water piped under gravity pressure to bottling works. Flow of 57,000 gallons a day; equivalent to 40 gallons a minute.

QUALITY OF GROUND WATER.

The results of two analyses and three assays of samples of ground water collected in Canton are given in the following table, together with the recalculation of an analysis published on the labels under which water is shipped for sale from Gra-Rock Spring. The waters are all low in mineral content, ranging from 32 to 140 parts per million of total dissolved solids. All are very soft waters; No. 84 is the softest and No. 29 the least soft of the Canton waters analyzed. They are all of the calcium-carbonate type, except Nos. 26 and 32, which are of the sodium-carbonate type, and No. 29, which is of the calcium-chloride type.

Chemical composition and classification of ground waters in Canton.

[Parts per million; samples collected Dec. 2, 1915; analyzed by S. C. Dinsmore. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 107–109.]

	Analyses.[a]			Assays.[b]		
	14	26	[c] 84	29	32	41
Silica (SiO_2)..........	13	9.0	14	....	....	....
Iron (Fe)..........	.40	.04	[d] .19	0.50	Trace.	0.50
Calcium (Ca)..........	7.5	7.0	2.4	....	....	....
Magnesium (Mg)..........	2.4	2.9	1.1	....	....	....
Sodium and potassium (Na+K)[e].	6.4	9.1	([f])	21	21	Trace.
Carbonate radicle (CO_3)..........	.0	.0	7.7	0	0	0
Bicarbonate radicle (HCO_3)...	22	29	....	54	68	34
Sulphate radicle (SO_4)..........	6.9	5.7	1.8	5	5	5
Chloride radicle (Cl)..........	6.0	8.0	1.2	43	19	5
Nitrate radicle (NO_3)..........	11	10	....	....	....	....
Total dissolved solids..........	59	63	[g] 32	[e] 140	[e] 110	[e] 60
Total hardness as $CaCO_3$..........	[e] 29	[e] 29	[e] 11	68	45	39
Scale-forming constituents [e]...	39	34	23	85	60	55
Foaming constituents [e]..........	17	25	8	50	60	Trace.
Chemical character..........	Ca-CO_3	Na-CO_3	Ca-CO_3	Ca-Cl	Na-CO_3	Ca-CO_3
Probability of corrosion [h]..........	(?)	(?)	N	(?)	N	(?)
Quality for boiler use..........	Good.	Good.	Good.	Good.	Good.	Good.
Quality for domestic use..........	Good.	Good.	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Date of collection of sample and analyst unknown; authority, label under which water is shipped. Recalculated from hypothetical combinations in grains per gallon to ionic form in parts per million.
[d] $Fe_2O_3+Al_2O_3$; sample contained a large amount of suspended iron.
[e] Computed.
[f] Determined; Na=2.3 and K=0.8 part per million.
[g] By summation.
[h] Based on computed value (?)=corrosion uncertain; N=noncorrosive.

PUBLIC WATER SUPPLIES.

Collinsville has been supplied by the Collinsville Water Co. since 1904. Water was obtained at first from springs on Huckleberry Hill, with which two covered reservoirs of 30,000 and 65,000 gallons capacity were connected. Later a concrete core-wall dam about 10 feet high, flooding $2\frac{5}{8}$ acres and giving a storage capacity of 2,500,000 gallons, was built on Nepaug River. The company has 11.5 miles of mains which supply water under gravity at a pressure of 80 pounds to the square inch. Twelve fire hydrants and 231 domestic service taps are supplied, and the average daily consumption is 145,000 gallons. Part of the reservoir that is being constructed on Nepaug River and Phelps Brook for the Board of Water Commissioners of Hartford will be in Canton.

CHESHIRE.

AREA, POPULATION, AND INDUSTRIES.

The town of Cheshire is in the north-central part of New Haven County, about 15 miles north of the city of New Haven. The principal settlement is Cheshire village, which is central in position and is composed of two parts, Cheshire and West Cheshire, so built up as to be almost continuous. Mixville is a small settlement in the western part of the town. There are post offices and stores at Cheshire and West Cheshire. The Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad runs through the town and has a station at West Cheshire and a flag station at Brooksvale, in the southern part of the town. The Meriden-Waterbury branch of the same railroad crosses the town from east to west and has flag stations at Cheshire Street, Southington Road, West Cheshire (separate from that on the Northampton division), and Summit. Cheshire is on the New Haven & Waterbury trolley line and is connected with the Meriden-Southington, Plainville & New Britain line at Milldale by a short branch.

The area of Cheshire is about 32 square miles. Woodlands are for the most part restricted to the hilly western part of the town and cover about 8 square miles. There are about 110 miles of roads, most of which are of dirt construction and well cared for. Some of the roads in the western part have bad grades, and some in the central part are sandy. The road which parallels the Northampton division was originally part of the New Haven and Farmington turnpike and is now a State trunk-line road.

Cheshire was originally part of Wallingford, but was incorporated as a separate town in 1780. In 1827 a little of the western part was cut off to form part of the town of Prospect. In 1910 Cheshire had a population of 1,988.

Population of Cheshire, 1782–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1782	2,015	1830	1,780	1880	2,284
1790	2,337	1840	1,529	1890	1,929
1800	2,288	1850	1,626	1900	1,989
1810	2,288	1860	2,407	1910	1,988
1820	2,281	1870	2,344		

[a] Connecticut Register and Manual, 1915, p. 653.

The loss of population in the decade from 1820 to 1830 was due to the cession of territory to form Prospect. About the middle of the century there was considerable mining of barite (barytes, or heavy spar), which probably accounts for the rather large population in 1860, 1870, and 1880. It is said that hundreds of miners were employed.[43] During the period that the Farmington canal was in operation (1827–1847) West Cheshire was a port for Waterbury and other manufacturing centers in the Naugatuck Valley. Although there is some manufacturing in Cheshire it is not a typical manufacturing town. The population probably will not grow much in the future but will continue, as in the last three decades, to fluctuate a little.

The principal industry in Cheshire is agriculture, which is carried on in fruit orchards, market gardens, and nurseries for forest trees. There is some manufacture of brass at West Cheshire and at Mixville.

SURFACE FEATURES.

Central and eastern Cheshire belong to the lowland province of Connecticut, comprising a rather level plain with low hills, but western Cheshire is part of the rugged western highland. The lowest point in the town is where Quinnipiac River crosses the east boundary, at an elevation of 100 feet above sea level. The highest point is the crest of Mount Sandford, in the southwest corner of the town, which is about 920 feet above sea level. This mountain is part of an intrusive trap sheet which extends, with a few interruptions, from New Haven to a point a little north of Milldale and forms the backbone of West Rock Ridge and its northward continuations. The sheet is thickest at Mount Sandford and therefore makes this point relatively high. North of Mount Sandford the sheet thins, and in Cheshire the outcrop becomes broken and in Southington, near Plantsville, dies out altogether.

Parallel to the southern part of the east boundary of Cheshire is a narrow dike of trap rock, about 20 feet wide and 4 miles long, known as Bristol Ledge. Like the trap of Mount Sandford it is of intrusive origin, but it was forced into a fissure that cuts the beds of sandstone instead of following them. About midway it is cut by a transverse dike. The ridges formed by these dikes are topographically prominent, for although they are not very high they are steep

[43] Beach, J. B., History of Cheshire, Conn., p. 273, 1912.

sided. Associated with the trap rock of the dikes is some copper, but it is so scanty that it has not been successfully mined.

The hills of the lowland part of Cheshire are gently rounded and not over 150 feet high. Their position and general shape were determined in preglacial time by normal weathering of rock of varying resistance. The ice sheet modified their forms by smoothing off the sharper angles and filling in the depressions with débris. The hills were left with smooth outlines and a mantle of till over their rock cores. Subsequently the hills were partly buried by stratified drift, which forms a very level plain above which rise the gently rounded sandstone hill and the steeper trap ridges.

West and northwest of Mixville the plain is bounded by the steep front of the western highland, which is underlain by more resistant rocks that have maintained a relatively high elevation despite erosion.

The southern part of Cheshire is drained by several branches of Mill River, which flows southward and enters Long Island Sound at New Haven. Mill River is one of the principal sources of supply of the New Haven Water Co. The northern part of Cheshire is drained by three tributaries of Quinnipiac River. Tenmile River has its headwaters in part in the highland and in part in the basin between the highland and the trap ridge, in which Mixville is situated. Broad Brook joins Quinnipiac River at Cheshire Street, and on it is a recently constructed reservoir of the Meriden system having a capacity of 1,200,000,000 gallons. Honeypot Brook enters the Quinnipiac about midway between Tenmile River and Broad Brook, and its headwaters are in a rather narrow and deep valley, the southern part of which is occupied by one of the headwaters of Mill River. It is probable that the Quinnipiac in preglacial time flowed southward through Cheshire to New Haven along either the Honeypot and Mill River valley or the broader depression which the railroad follows, instead of taking its present roundabout course through Meriden and Wallingford.

WATER-BEARING FORMATIONS.

In Cheshire ground water is obtained both from the consolidated bedrocks and from the overlying till and stratified drift. The bedrocks include the Hoosac schist and Prospect porphyritic granite gneiss, which underlie about 4 square miles in the western part of the town, and the sandstone and trap of Triassic age.

Schist and gneiss.—The Hoosac schist, so called because of its type exposure at Hoosac Mountain, Mass., crops out here and there in a strip a mile wide along the Waterbury boundary of Cheshire. It is composed essentially of flakes of mica, both light and dark, and granules of quartz, in addition to which garnets and a few other minerals are found as auxiliaries. The mica flakes are arranged roughly parallel to one another and so give the rock its highly fissile, schistose character. The minute openings between the mica flakes

are to a large extent filled with water that has percolated into them from the overlying mantle of soil, but the larger and more extensive fissures that transect the rock in many directions are far more effective as storage spaces and as channels of circulation for water.

The porphyritic granite gneiss is a grayish rock consisting essentially of bands of granular quartz and feldspar separated by darker layers in which biotite (dark mica) is the dominant mineral. There are many larger crystals of feldspar which attain a maximum length of 2½ inches and which give the rock its porphyritic character. Since the original consolidation of the rock it has been subjected to mechanical stress, which has produced many extensive fissures and joint openings.

No wells that derive their supply from either the gneiss or the schist were found, but there is good probability of success in drilling into these rocks. It has been found elsewhere in the State that "not less than 90 per cent of the wells sunk in the crystalline rocks have given supplies sufficient for the use required." [44]

Sandstone.—The sandstones and shales which underlie the central and eastern parts of Cheshire are tilted so that the bedding planes dip 15°–20° E. They are cut by many joints and fissures that were formed by the jarring incident to the tilting. A number of drilled wells and a few dug wells draw water from such cracks. No part of this formation seems to be sufficiently porous to carry water in the interstices between the grains. Information was obtained concerning 26 wells drilled in these rocks, and their depth was found to average 75 feet. The probability of success for drilling operations in the Triassic sandstone area of Connecticut has been estimated at about 94 per cent.[45] It is considered "good practice to abandon a well that has not obtained satisfactory supplies at 250 to 300 feet."

Till.—Till mantles most of the surface of Cheshire above an elevation of 160 to 180 feet above sea level, and forms a layer as much as 30 feet or even more in thickness. It is a dense mass of tough clay or rock flour with some silt and sand and boulders of various sizes. The constituents of the till have no regularity of arrangement. Part of the water that falls as rain is absorbed into its minute pores. Though the upper part of the till may be devoid of water after long droughts, there is in general a good deal in the lower parts. Wells dug in deposits of this sort have fairly abundant and fairly reliable supplies of water. In some exceptional places the till has been worked over by water so that it is more pervious and yields larger and more reliable supplies. The average depth to water in the wells dug in till that were visited in Cheshire is 14 feet, the range being from 3.1 feet in well No. 26a (see Pl. III) to 35 feet in well No.

[44] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 92, 1909.
[45] Idem, p. 130.

68a. Information as to the reliability of supply was procured for 30 of the wells, of which 17 were said to be reliable and 13 were said to fail. Well No. 39 indicated an unusually great fluctuation of the water table, for although there was 17.2 feet of water in it when it was measured (April 21, 1915) it is said to fail. This fluctuation of 17.2 feet or more is probably due to the location of the well on a steep slope from which the water drains readily.

Stratified drift.—Stratified drift covers the bedrock of the lower parts of Cheshire. It is composed of well-washed and sorted sand, silt, and gravel which were carried out from the ice sheet by the great streams of melted ice during its recession from the region. As a result of the washing the pores are larger and connect better with one another than those of till, and consequently the water circulates more rapidly. Forty wells dug in stratified drift were visited and measured. The greatest depth to water was found in well No. 55 (see Pl. III) and was 46 feet. This well is near the edge of a terrace, a fact which probably explains the great depth. Well No. 87, in which the minimum depth of 5.2 feet was found, is, on the other hand, on a broad plain where there is less chance for the ground water to flow away. The average depth to the water level in these wells was found to be 16.4 feet. The reliability of 35 of them was ascertained, and of these 25 were reported to be nonfailing and 10 were said to fail more or less regularly in dry seasons.

RECORDS OF WELLS AND SPRINGS.

Information was collected concerning 85 dug wells, 2 driven wells, 30 drilled wells, and 8 springs in Cheshire.

Dug wells ending in till in Cheshire.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
2		Plateau	665	22.4	15.6	Deep-well pump	Rock bottom; unfailing.
3		Slope	540	11.1	8.2	Two-bucket rig	
5		do	420	14.0	5.2	do	Fails.
6		do	340	14.0	6.4	Windlass rig	Unfailing.
10		do	240	24.5	16.5	Two-bucket rig	Fails.
12		Plain	220	13.2	9.3	Windlass rig	Unfailing.
13		Slope	240	30.3	23.7	Two-bucket rig	
15		do	205	24.7	20.3	do	Do.
28		Hilltop	290	16.2	9.6	Sweeping	Fails.
31		Slope	200	16.2	8.7	Windlass and pulley rig.	Do.
39		do	220	31.0	13.8		Do.
42		Plain	230	25.7	16.2	Two-bucket rig	Unfailing.
49		Slope	250	15.0	6.7	do	Tiled; fails.
50		Plateau	255	18.7	9.9	do	Unfailing.
51	Mr. Woodbury	do	265	24.8	15.0	do	Do.
52		do	260	15.8	8.7	do	
53		Slope	255	24.1	20.8	do	
58		Plain	250	24.8	18.2	Two-bucket rig	15 feet in rock; unfailing.
60		do	250	13.3	9.3	Chain pump	Clear.
64		Slope	215	32.8	33.6	Two-bucket rig	Unfailing.
65		Plain	255	22	9		12 feet in rock; unfailing.

Dug wells ending in till in Cheshire—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
65a	....	Plain...	255	......	35	....	25 feet in rock; unfailing.[a]
67	....	Slope...	265	14.7	9.2	Chain pump........	Fails.
70	....	Plain...	190	27.6	24.5	Two-bucket rig	
76	....	...do....	200	23.4	18.7	.....do.............	Unfailing.
77	....	Slope...	240	18.8	15.5	Windlass rig........	
80	....	Plain...	235	25.4	21.9	Two-bucket rig.....	Fails.
84	....	Steep...	240	26.4	19.9	.....do.............	Unfailing.
90	....	...do....	210	21.8	12.0	.....do.............	
92	....	...do....	165	18.8	16.2	.....do.............	
94	....	Slope...	190	25.1	14.3	.....do.............	Rock bottom; fails.
96	....	Swale...	275	18.9	13.6	Deep-well pump....	Unfailing.
97	....	Hilltop .	265	16.2	9.5	Two-bucket rig.....	
98	....	...do....	285	21.9	11.3	Two-bucket rig and house pump.	
100	....	Slope...	220	30.2	25.4	Two-bucket rig.....	
101	Henry Metzler...	...do....	260	12.8	8.5	.....do.............	Unfailing.[b]
102	....	Hilltop..	315	20.7	14.0	....	At house; 11 feet in rock; fails.
102a	....	...do....	305	28.5	18.9	....	18 feet in rock; fails.[c]
102b	....	...do....	310	17.3	11.2	....	Rock bottom; fails.[d]
109	....	Slope...	200	23.4	14.2	....	
110	....	Plain...	220	13.6	7.6	Windlass rig and gasoline engine.	Unfailing.
111	....	Slope...	265	21.9	13.5	Two-bucket rig and house pump.	Fails.
112	....	...do....	230	10.7	6.0	Two-bucket rig.....	2 feet in rock; fails.

[a] 100 feet west of well No. 65.
[b] Rock bottom; temperature 44° F.
[c] 90 feet southwest of well No. 102.
[d] 100 feet northwest of well No. 102.

Dug wells ending in stratified drift in Cheshire.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
7	....	Slope....	185	20.0	10.0	....	Unfailing.
8	....	...do....	190	21.4	18.6	....	Fails.
17	E. P. Dunham..	Plain...	190	24.5	10.0	Two-bucket rig.....	
18	....	...do....	185	37.9	29.5	Windlass...........	Do.
19	....	...do....	180	33.3	24.0	.....do.............	Unfailing.
22	....	...do....	195	23.0	20.1	Two-bucket rig.....	
23	....	...do....	155	23.5	15.6	.....do.............	Do.
25	....	Hill.....	220	18.8	15.5	.....do.............	Do.
26	....	Plain...	180	19.0	13.7	Wheel and axle rig..	13 feet in rock. Fails.
26a	....	Slope...	175	16.1	3.1	....	Unfailing.
27	....	Plain...	185	25.0	16.6	Two-bucket rig.....	Fails.
29	....	...do....	185	......	9.0	Power pump........	
30	....	Slope...	160	12.1	7.0	Two house pumps..	
37	....	...do....	205	17.4	9.2	Two-bucket rig.....	Unfailing.
41	....	Valley..	190	19.0	16.1	.....do.............	Ends in quicksand; fails.
44	....	Plain...	155	25.2	23.4	.....do.............	
46	....	...do....	155	17.9	14.9	.....do.............	Unfailing.
47	....	...do....	185	29.7	23.1	.....do.............	Rock bottom; unfailing.
48	....	...do....	190	20.1	9.2	.....do.............	Unfailing.
54	Wm. Krumm...	Valley..	130	21.9	19.3	.....do.............	Tiled.
55	....	Plain...	200	44.8	42.6	Two-bucket rig and gasoline engine.	Unfailing.
56	....	...do....	195	28.7	18.7	Two-bucket rig.....	Do.
57	....	...do....	200	20.2	13.6	House pump........	Fails.
62	....	Slope...	125	17.6	15.2	Windlass...........	Abandoned.
68	....	...do....	160	15.1	12.1	Two-bucket rig.....	Unfailing.
69	....	Plain...	180	25.9	17.1	Windlass...........	Do.
71	....	Slope...	175	18.7	15.3	Deep-well pump....	Do.
72	....	...do....	165	16.3	13.2	Two-bucket rig.....	Do.
73	....	...do....	180	30.3	26.0	.....do.............	Do.
75	....	Plain...	195	33.6	33.0	.....do.............	Do.
83	....	...do....	140	18.0	17.1	.....do.............	Fails.
85	....	Slope...	190	43.2	11.8	.....do.............	Unfailing.
86	....	...do....	185	18.6	13.6	.....do.............	Do.
87	....	Plain...	175	9.7	5.2	Chain pump........	Do.
89	....	...do....	170	15.7	12.3	Two-bucket rig.....	Do.
91	....	...do....	155	18.4	15.5	.....do.............	Do.
99	....	...do....	135	23.1	16.3	Windlass...........	Fails.

Dug wells ending in stratified drift in Cheshire—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
108	....	...do....	195	18.9	14.9	Two-bucket rig.....	Unfailing.
113	Warren J. Andrews.	...do....	165	12.6	11.1	Chain pump.........	Unfailing; for analysis see p. 117.
114	....	...do....	165	10.9	8.7	Two-bucket rig.....	Unfailing.
115	....	...do....	170	14.9	13.2	.....do............	Fails.
116	....	...do....	160	20.0	17.5	.....do............	Unfailing

Driven wells in Cheshire.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Diameter.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	
24	....	Plain..........	160	38	....	....	Unfailing.
88	....	......do.........	195	34	....	3	(a).

a An 18-foot dug well deepened by a 16-foot pipe 3 inches in diameter with 250 holes ¼ inch in diameter; a 2-inch pipe inside connected to pump; yields 60 gallons a minute.

Drilled wells in Cheshire.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
1	Edwin A. Todd.	Hill.....	670	90	70	....	....	Schist.......	
4	....	Slope....	515	67	4½	6	1½	.....do.......	
11	Connecticut Brass Co.	Plain....	200	38	....	....	....	Sand and gravel.	
20	....	...do.....	185	96	84	6	....	Sandstone...	
20a	....	...do.....	185	44	....	6	....	Sand and gravel.	(a).
21	Peck............	...do.....	185	....	60	6	....	Sandstone...	
32	E. R. Minor....	Slope....	215	22	15	6	30	.....do.......	Water enters at 22 feet.
33	Glannap........	Hilltop .	265	69	24	6	30	.....do.......	
34	Reinhard........	...do.....	265	75	18	....	4	.....do.......	
35	Wheeler.........	Slope....	240	60+	9	....	30	.....do.......	
36	....	...do.....	200	50	14	6	7 to 8	.....do.......	
38	....	Hilltop..	225	90	....	....	....	Sand.........	
40	Gilbert Williams	Slope....	225	55	....	6	....	Sandstone...	
43	Walter Scott estate.	Hilltop..	265	320	20	....	25	.....do.......	
45	Michael J. Gillen	Plain....	155	68	....	6	....	.....do.......	
59	T. W. Williams.	...do.....	240	88	5	6	6	.....do.......	(b).
60	....	Slope....	230	68	10	6	7½	.....do.......	
74	....	Plain....	195	56	....	....	....	.....do.......	
74a	....	...do.....	195	47	....	4	....	.....do.......	(c).
78	....	Slope....	160	35	....	6	Low.	Sand and gravel.	
78a	....	...do.....	160	76	....	6	Low.	....	(d).
79	J. B. Dill estate.	...do.....	200	56	Slight.	8	Large.	....	
93	F. J. Craigs.....	...do.....	190	80	6	6	....	Sandstone...	
93a	.....do..........	...do.....	190	56	6	6	Fails.	.....do.......	(e).
95	J. C. Parkins...	...do.....	190	82	....	....	....	.....do.......	
103	J. B. Gibson....	...do.....	320	60	10	60	....	.....do.......	For assay see p. 117.
104	Curnow Bros...	...do.....	265	44	4	6	....	.....do.......	(f).
105	J. Moon.........	...do.....	270	31	4	6	15	.....do.......	For assay see p. 117.
106	Albert LeClaire.	...do.....	280	59	10	6	1½	.....do.......	
117	E. D. Moon.....	Ridge...	280	85	2	6	....	.....do.......	(g).

a Well No. 20 abandoned when string of tools was lost and before water was reached. Well No. 20a was drilled only 12 feet away and found a good supply at 44 feet in gravel.
b Water enters at depths of 35, 40, and 85 feet.
c Wells Nos. 74 and 74a draw from a fine sand.
d 125 feet southwest of well No. 78.
e Well No. 93 is at barn and 100 feet west of well No. 93a, which is at the house.
f Temperature is 50° F.
g Well is only 12 feet from the "Bristol Ledge" dike of trap rock. It was drilled in part through whitish and bluish metamorphosed sandstone.

Springs in Cheshire.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	° *F.*	*Gallons.*	
9	....	Slope........	200	47	1	Gravity rig; unfailing.
14	....	......do........	230	47	....	Do.
16	....	......do........	320	43	....	Do.
63	....	......do........	135	49	....	Roadside.
66	....	......do........	290	57	....	Unfailing.
81	....	......do........	160	51	....	
82	Rev. J. Trigaskis........	Foot of slope..	130	49	1	Unfailing; for analysis see p. 117.
107	....	Slope........	200	49	2½	Fails.

QUALITY OF GROUND WATER.

In the following table are given two analyses and two assays of samples of ground water collected in Cheshire. All the waters are soft, but No. 113 is softer than the rest. They are all of the calcium-carbonate type except No. 113, which is a sodium-nitrate water. The mineral content of all the waters analyzed is low, ranging from 78 to 130 parts per million.

Although low in both scale-forming and foaming constituents, No. 113 is rated as only fair for boiler use on account of its tendency to corrode boilers. The owner of the well states that the water gives considerable trouble by corroding kitchen utensils. Nos. 103 and 105 are also classed as fair for boiler use on account of the amounts of scale-forming constituents present. No. 82 is good for boiler use.

On the basis of the mineral content all the waters are classed as good for domestic use, although No. 113 contains excessive nitrate, which may indicate pollution from surface drainage.

Chemical composition and classification of ground waters in Cheshire.

[Parts per million; samples collected Nov. 12, 1915; analyzed by S. C. Dinsmore. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 115–117.]

	Analyses.[a]		Assays.[b]	
	82	[c] 113	103	105
Silica (SiO_2)	15	14	....	....
Iron (Fe)	.05	.20	Trace.	Trace.
Calcium (Ca)	14	6.9	....	....
Magnesium (Mg)	2.8	2.8	....	....
Sodium and potassium (Na+K)[d]	11	[e] 25	7	6
Carbonate radicle (CO_3)	.0	.0	0	0
Bicarbonate radicle (HCO_3)	66	12	95	100
Sulphate radicle (SO_4)	4.5	20	5	10
Chloride radicle (Cl)	8.0	15	17	5
Nitrate radicle (NO_3)	Trace.	30	....	....
Total dissolved solids	78	123	[d] 130	[d] 120
Total hardness as $CaCO_3$	[d] 46	[d] 29	94	88
Scale-forming constituents [d]	61	39	110	100
Foaming constituents [d]	30	68	20	20
Chemical character	Ca-CO_3	Na-NO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion [f]	N	C	(?)	(?
Quality for boiler use	Good.	Fair.	Fair.	Fair.
Quality for domestic use	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Composite of two samples collected Nov. 12 and Dec. 5, 1915; analyzed by Alfred A. Chambers, U. S. Geol. Survey.
[d] Computed.
[e] Determined.
[f] Based on computed value; N=noncorrosive; C=corrosive; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

There is no public water supply serving Cheshire exclusively, but the New Haven Water Co. in 1914 had 166 customers in the town.[46] Water is supplied from the main that carries water from the Prospect reservoir to the villages in Hamden and to some parts of the city of New Haven. The reservoir on Broad Brook, in the northeastern part of Cheshire, is part of the Meriden system and has a capacity of 1,200,000,000 gallons.

Should it become necessary to develop a fair-sized supply of water in Cheshire there would be two solutions of the problem. Reservoirs from which water could be distributed by gravity could be constructed on one or more of the tributaries that come into Tenmile River from the west; or a pumping plant drawing from driven wells could be built on one of the stratified-drift plains. The driven well numbered 88 on the map (Pl. III) yields at least 80 gallons a minute and shows the feasibility of such a plan.

FARMINGTON.

AREA, POPULATION, AND INDUSTRIES.

Farmington is near the center of Hartford County, about 10 miles west of the city of Hartford. Most of it is in the central lowland province, but a section of the valley trap ranges occupies the eastern third of the town. The villages of Farmington, in the center of the town, and Unionville, in the northwest corner, are the principal settlements, and at each are post offices, banks, and stores. Rural delivery routes serve the outlying districts. The Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad runs north and south through the town. Farmington Station, on this line, is also the junction point of the New Hartford branch of the Northampton division, which has a station also at Unionville. Farmington village and Farmington Station are connected by stage, and a trolley line between Hartford and Unionville runs through Farmington village.

The area of Farmington is about 29 square miles. There is a large stretch of woodland in the southeast corner of the town and on Rattlesnake Mountain, which with other woods, chiefly along the east, north, and west boundaries, has an area of 10½ square miles, or about 35 per cent of the total area of the town. There are in Farmington about 60 miles of roads, of which 11 miles are State roads of bituminous macadam and belong to trunk lines that radiate from Farmington village to Plainville and New Britain, to Unionville, and to Hartford. Most of the dirt roads are kept in excellent condition,

[46] Connecticut State Public Utilities Comm. Rept. for 1914.

although some of the grades in the eastern part of the town are severe and some of the roads in the central part are sandy.

Farmington was first settled in 1644 and was named in 1645. It then had an area of about 190 square miles, but the towns of Avon, Bristol, Burlington, New Britain, Plainville, and Southington and parts of Berlin and Wolcott have been taken from it at various times. In 1901 Farmington village was incorporated as the Borough of Farmington. In 1910 the town had a population of 3,478, of which 897 were assigned to the borough. The following table gives the changes in population from the first census after the cession of Avon:

Population of Farmington, 1830-1910.[a]

Year.	Population.	Year.	Population.	Year.	Population
1830	1,901	1860	3,144	1890	3,179
1840	2,041	1870	2,616	1900	3,331
1850	2,630	1880	3,017	1910	3,478

[a] Connecticut Register and Manual, 1915, p. 653.

The decrease in population in the decade from 1860 to 1870 was due to the separation of Plainville, which in 1870 had a population of 1,433. Considered together the territory of these towns increased in population in this decade. The growth of Farmington has been moderate but fairly steady. The greater part of Farmington is a farming region in which many wealthy people, chiefly from Hartford, have fine country places. A number of sites with excellent views have been developed on the crests of the trap ridges. Only a moderate increase in population is to be expected in such a district. Unionville, however, is a busy manufacturing place at which paper, nuts and bolts, cutlery, and rules and levels are made. Presumably there will be a steady though moderate increase in population in and around Unionville due to the natural growth of the manufactories. In this vicinity provision must be made at frequent intervals for increasing the public water supply. Less attention to this phase of the water problem will be needed in the rest of the town.

SURFACE FEATURES.

The topographic elements of Farmington are a central sand plain above which rise several rock drumlins, trap ridges along the east side of the plain, and a higher till-covered plain in the southeast corner. The total range of elevation is about 600 feet. The lowest point in the town is where Farmington River crosses the Avon town line, at about 150 feet above sea level, and the highest point is the crest of Rattlesnake Mountain, in the southeastern part of the town, 750 feet above sea level.

The Farmington sand plain occupies the strip through the center of the town but widens from about 2 miles at the south to about 4 miles at the north. It may be divided into two subordinate elements—a low flood plain and a terrace plain 20 to 40 feet higher, on part of which the village of Farmington is built. The sand plain is composed of stratified material laid down by water that ran from the ice sheet as it melted back from the region. A little south of Plainville an excess of this material was heaped up to a slightly greater height than elsewhere in the valley.[47] Whether this extra accumulation was due to a prolongation of the process during a halt in the recession of the glacier or to the carrying in of much detritus from the west by Pequabuck River is uncertain. At all events, the deposits were heaped up at this point and blocked the valley so that a lake was formed on the north. Probably the small tributaries of this ancient lake were forced to drop their loads of detritus and so built up terrace-like deltas near the shores. Although the coarser materials were thus deposited near the shores of the lake, the finer materials were carried well out into the lake before they were laid down. Deposits that seem to be of such origin were found in the bed of Farmington River a little north of Farmington village, in the construction of a crossing for the pipe line from the new Nepaug reservoir to Hartford.

A very striking feature of the sand plain is the great number of pitch pines (*Pinus rigida*) growing on it. Plate VI, *A*, is reproduced from a photograph taken about three-eighths of a mile south of Farmington Station and shows an almost clear stand of these trees.

The till plain in the southeast corner of the town is of a very different origin. It was cut to about its present form in preglacial time and has been since modified only by the deposition of a mantle of till. The present surface is poorly drained and marshy by nature, but a canal dug southwestward from Hartford reservoir No. 4 has somewhat modified this condition.

The two plains are separated by a belt of very hilly country a mile or two wide, the ruggedness of which is due to the cliff-forming edges of eastward-tilted sheets of trap rock. The upper of the two sheets is the thicker (400 to 500 feet) and is known as the "Main" sheet, as it is the more prominent. The lower is thinner (250 feet or less) and is called the "Anterior" sheet, as it crops out below the face of the principal cliff. The cliff formed by the "Main" sheet is highest at its south end, where it forms Rattlesnake Mountain, but toward the north it is progressively lower, and in the northeast corner of the town it forms only a very small ridge. This diminution of height is due to a large fault which cuts the ridge at a very oblique angle and so tapers

[47] Davis, W. M., Triassic formation of Connecticut: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, p. 181, 1898.

[48] Idem, pp. 96–121, pl. 19.

A. YELLOW PINE (PINUS RIGIDA) NEAR FARMINGTON STATION.

B. WHITE PINE (PINUS STROBUS) NEAR GRANBY STATION.

off the outcrop.[48] The fault presumably does not cut the "Anterior" sheet, as that sheet is almost continuous throughout the town and forms prominent cliffs for much of its length.

Along part of the eastern margin of the till plain is a low ridge of trap rock that belongs to a third trap sheet (100 to 150 feet thick), which is called the "Posterior" sheet, as it crops out back of the cliff of the "Main" sheet. This sheet seems to be repeated on another low ridge a quarter of a mile to the southeast, and the recurrence is probably due to a small fault bearing north-northeast, the east side of which has been raised. Possibly the second ridge is a local sheet, but the evidence is hidden by the till mantle.

The narrow area of stratified drift along the east boundary of the town is a portion of the great sand plain of New Britain and Newington and is essentially like that of the Farmington Valley.

The hillside on which the northwest corner of Farmington lies is part of the western highland and is underlain by schist. It is covered by a mantle of till, as are also the two hills which rise from the central sand plain. One of these is northeast of Unionville and extends northward to Pond Ledge Hill in Avon. The second of these rock drumlins, or till-mantled rock hills, covers about 5 square miles along the west boundary of the town. They are hills which escaped burial under stratified drift. It is believed that their elevation is due to their being underlain by a zone of the sandstone that is coarser and better cemented than that beneath the sand plain.

Farmington is drained by Farmington River and some of its tributaries, of which the chief one is Pequabuck River. The Farmington enters the northwest corner of the town, flows southeastward about 5 miles, and then turns in a sweeping curve into a northward-flowing reach that extends about 13 miles through Avon and Simsbury. The flow of this stream has been studied by the Board of Water Commissioners of Hartford, who have maintained an automatic gaging station at Farmington village for several years. The maximum discharge for the year 1913—17,000 second-feet—occurred on October 26 and 27, after a rainfall of 6 to 7 inches at several points in the drainage basin.[49] This is equivalent to a discharge of 37.9 second-feet per square mile for the 449 square miles of tributary drainage area. The minimum flow for the same year occurred in August and was 0.222 second-foot per square mile, which is equivalent to 100 second-feet at Farmington.

The courses of the Farmington and the Pequabuck lie mainly in the sand plain, where relatively few tributaries join them. There are more brooks entering Farmington River where it passes close to the till-covered lower slopes of the trap ridges. One fair-sized brook

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[49] Hartford Board of Water Commissioners Sixtieth Ann. Rept., p. 45, 1914.

rises in Scotts Swamp and flows eastward to Pequabuck River, and two others enter the Farmington from the southwest between Unionville and the "big bend." Two streams join Farmington River from the north side of the bend—Roaring Brook (see Canton report, p.105) and Poplar Swamp Brook.

The fewness of the tributaries in the sand-plain sections of these stream courses is due to the porosity of the soil. The water that falls as rain, instead of collecting in streams, soaks into the ground and becomes part of the ground-water body. It is probable that there is considerable discharge of ground water directly into those rivers through their beds. Springs are few in this section and are for the most part restricted to low marshy spots at the foot of the terraces. The water table is low, and the lack of permanent moisture in the upper soil is indicated by the abundance of dry-land vegetation, such as pitch pine, scrub oak, and "poverty" grass.

WATER-BEARING FORMATIONS.

The bedrocks of Farmington include sandstone, shale,[60] and trap rock of Triassic age and the much older Hoosac schist.

Schist.—The Hoosac schist, which is restricted to a small area in the northwest corner of the town, is a typical closely laminated, fissile, light to dark gray mica schist and is composed essentially of mica flakes and quartz grains, with small amounts of garnet, staurolite, and other minerals. In some places there are many thin veins of quartz and pegmatite. The minute fissures between the laminae carry a little water but would not be as satisfactory a source of supply as the larger joints and fractures. No development of such a supply has been made in Farmington, but in other towns drilled wells in the Hoosac schist have obtained water from the larger cracks in quantities sufficient for domestic and farm requirements.

Sandstone and shale.—The sandstones underlying the gently rounded hills of the southwest corner of the town have been used to some extent as a source of water. These rocks are rather extensively fissured as a consequence of the movements which tilted them. Drilled wells are likely to intersect one or more fissures bearing water within a reasonable distance. The depth of eleven drilled wells in Farmington, believed to derive their supplies from this formation, averages 178 feet and ranges from 41 to 480 feet. In choosing a site for drilling convenience is the chief consideration, as there is no way of determining the location of underground fissures. The fissures are so numerous that there is a high probability of success—about 19 chances in 20. (See p. 113.) The fissures are more abundant near the surface

[60] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 132, 1909.

than farther down, and it is held to be "good practice to abandon a well that has not obtained satisfactory supplies at 250 to 300 feet.[50]

Over much of the sand plain the red sandstone and shale lie at a depth of perhaps 100 to 200 feet, as is indicated by the Trumbull Electric Manufacturing Co.'s drilled well in Plainville, which reached rock at 218 feet. Two drilled wells in Avon have a similar significance: One reached bedrock at 90 feet and the other did not reach rock in its total depth of 85 feet. In this part of Farmington, then, it would not be necessary to drill to bedrock, for excellent supplies would be found in the unconsolidated stratified drift above.

Trap rock.—The trap rocks carry water in much the same way as the sandstones and shale but not to the same degree. On account of the resistance of this rock to weathering it stands up as high ridges, and there is great opportunity for the water to drain out of the fissures at lower levels. This would be particularly true of wells near the edges of the trap cliffs. The hardness of the trap makes drilling very slow and expensive, but the undertaking is worth while where other sources of supply are not available or are unreliable.

Stratified drift.—Water is obtained in great abundance from the stratified drift by means of dug and driven wells, not only on the present flood plains but also on the higher terraces. The greatest difficulty in the construction of wells is the tendency of the very fine silt to behave like quicksand. Deepening a dug well through such silt below the ground-water level is very difficult. Large tiles of earthenware or cement can be used as a sort of caisson to keep out the silt during the digging. Another plan is to sink a drive pipe within the well, as was done with wells Nos. 48–B and 91. (See Pl. III.) The drive pipe should not be left in such a position that the screen is in silt, else it will clog badly and silt will get into and wear the pump. The screen should be in a bed of gravel or coarse sand.

Of the 60 wells dug in stratified drift that were visited in Farmington, 8 were found to be dry (October, 1914), 10 more were said to fail, and 10 were said to be nonfailing, but the reliability of the remaining 32 wells was not ascertained. The depth to the water in the 52 wells which had any water ranged from 6 feet in well No. 13 (see Pl. III) to 19.8 feet in wells Nos. 93 and 98, and averaged 16.3 feet.

Till.—In the till-covered parts of the town dug wells seem to be more successful. The reliability of 23 wells was ascertained, and 16 were said to be nonfailing. The very fine pores of the soil from which these wells draw water tend to retard the escape of water to lower areas, so that the water level is in many places near the surface, even on hills and slopes. The till is a mixture of ice-worked débris of all sorts and in fragments of all sizes from the finest of clay and rock flour up to big boulders. It was deposited directly by the ice without intervention of any appreciable aqueous action, else the

finer constituents would have been eliminated and the rest sorted out according to size. Of the 78 wells dug in till that were visited in Farmington, 9 were found to be dry. The depth to water in the remaining 69 wells averaged 15.5 and ranged from 3.3 feet in well No. 150a to 32.8 feet in well No. 22.

There are many springs on the till-covered slopes below the trap cliffs. Many of these have been improved by means of small reservoirs, and their water is piped by gravity to the houses below.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Farmington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
14		Slope	260	27.0		Deep-well pump	Fails.
15		do	290	24.5	21.5	do	
16		do	305	6.8	4.3	Windlass	Abandoned.
19		do	290	22.2	21.0	House pump	
20		do	310	30.0		Deep-well pump	Fails.
22		Hilltop	320	34.7	32.8		24.5 feet in sandstone.
23		do	330	14.3	12.2	Chain pump	
24		do	330	19.2	18.6	Pitcher pump	
25		do	350	19.1	18.2	Windlass	Unfailing.
26		do	385	13.7	11.8		
27		do	370	19.7	15.2	Chain pump	Do.
28		Slope	350	20.3	12.9	One-bucket rig	
28a		do	350	12.5	11.3	Chain pump	([a]).
29		Plain	340	22.4	21.0	Deep-well pump	
30		do	340	12.5			Reaches rock. Fails.
31		do	330	22.4	17.9	Chain pump	Unfailing.
32		do	320	8.4	7.9		Abandoned.
33		do	320	19.0	16.4	([b])	
34		do	305	24.0	19.5	Windlass	Do.
35		Slope	295	16.5	14.4	Chain pump	Unfailing; Dug into rock.
36		Knoll	280	19.8	15.7	do	([c]).
37		Plain	270	16.7	13.5	do	
38		Slope	305	23.2	8.6	Windlass	
40		do	200	9.8	4.4	Chain pump	
41		do	220	26.6	14.1	do	Unfailing.
42		do	230	19.0	12.7	House pump	
43		do	250	12.0	10.6	do	
44		do	240	7.3	5.3		Abandoned.
46		Valley	230	15.2	14.3	House pump	
47	Peck Bros.	Slope	230	12.6	10.0	Chain pump	Unfailing.
48	do	do	225	17.9	17.0	Two-bucket rig	
52		Plain	325	16.6	12.0		
53		do	335	23.1	21.5	House pump	
53a		do	335	12.8	9.2		([d]).
54		do	335	20.3	15.1	Chain pump	Unfailing.
55		do	330	11.6	10.8	Sweep rig	
56		do	325	13.0	12.1	Two-bucket rig	Do.
56a		do	325	9.0	6.6	Gasoline engine	9-foot diameter. Unfailing.[e]
57		do	325	13.0	12.3	Two-bucket rig	Unfailing.
58		do	325	12.9	10.2	Chain pump	
59		do	315	26.9	26.5	Deep-well pump	Do.
60		do	310	21.8	13.3		Do.
61		do	310	18.9	17.8	House pump	
62		do	310	32.8	26.8	Deep-well pump	
64		Valley	290	12.0	11.0	Chain pump	
81		Plain	300	22.6	20.0	Windlass	Do.
110		Slope	210	31.4			Fails.
120		do	310	19.0	16.5	Two-bucket rig and gasoline engine.	
121		do	225	14.7	14.3	Two-bucket rig	
122		do	220	22.3	19.7	do	Unfailing.

[a] 100 feet south of well No. 28. Dug to rock.
[b] No rig.
[c] Measured on several dates; depth of water August 15, 1914, 4.1 feet; Sept. 4, 4.2 feet; Oct. 1, 2.7 feet.
[d] 250 feet east of well No. 53.
[e] 330 feet west of well No. 56.

Dug wells ending in till in Farmington—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
123		Slope	210	26.6	23.9	Two-bucket rig	
124		do	320	31.3	29.0	Chain pump	Unfailing.
127		Hilltop	280	21.0	19.9	Windmill	Tiled.
129		Slope	360	16.3		Windlass	Fails.
130		do	365	20.4		(*a*)	Abandoned; fails.
133		do	380	14.6	13.4	House pump	
135		Hilltop	325	39.5	28.1	Chain pump	
136		do	400	17.1	14.8	do	
137		Plain	345	20.0	19.1	Two-bucket rig	Blasted into trap rock.
138		do	350	12.6		Chain pump	Fails.
139		do	345	13.0	11.7	do	
140		do	345	12.5	10.7	do	
140a		do	310	8.5	6.6	(*a*)	(*b*).
141		Swale	340	15.9	11.6	Deep-well pump	
142		Slope	370	22.0	12.6	Chain pump and windmill.	
143		do	300	37.1	29.2	Windlass	Unfailing.
144		do	375	19.3	19.1	do	
146		do	365	19.0	16.9	do	Do.
148		do	330	11.0		Two-bucket rig	Fails.
149		Slope	355	23.1	18.0	Chain pump	Abandoned
150		do	340	24.8	21.7	Deep-well pump	Do.
150a		do	300	7.7	3.3	Windmill	(*c*).
151		Ridge	265	13.1	12.0	Deep-well pump	
152		Slope	250	26.6	17.2		House vacant.
153		Plain	175	15.0	14.0		
154		Slope	340	46.2	21.6		Abandoned.
155		do	300	12.2		Windlass	Fails.
156	Hartford Water Commission.	do	310	26.0	16.3	Chain pump	For assay see p. 128.

a No rig.
b In barnyard, 150 feet north of well No. 140.
c 275 feet northwest of well No. 150 and 36 feet lower.

Dug wells ending in stratified drift in Farmington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1		Plain	230	12.6	11.8		(*a*).
3		Slope	230	23.5	21.8	House pump	Unfailing.
4		do	210	12.2		Chain pump	Fails.
6		do	260	9.0	6.5		Unfailing.
7		do	290	27.4	25.2	Windlass rig	Do.
8		do	300	32	30	Deep-well pump	
8a		do	310	31	28	do	(*b*).
10		Plain	185	12.8	11.1	House pump	
11		do	175	17.2	13.2	Chain pump	Tiled.
12		do	190	39.9	18.0	do	Unfailing.
13		do	205	7.2	6.0	House pump	Fails.
17		Slope	280	21		Deep-well pump	Do.
21		Hilltop	300	23.1	20.5	do	
49		Slope	185	13.8		House pump	Tiled; abandoned; fails.
65		Plain	210	25.3	24.6	House pump	
66		Slope	230	20.1	17.6	do	
67		Plain	240	16.4	14.0	Chain pump	
68		do	245	21.8	20.1	House pump	
69		do	250	13.2	12.1	Deep-well pump	Fails.
70		do	255	20.2			Abandoned; fails.
71		do	255	18.2	17.3	Deep-well pump	
72		do	250	29.1	26.5	Deep-well pump and two-bucket rig.	(*c*).
73		do	250	22.7	20.6	Chain pump	
74		do	250	21.4	21.2	do	Abandoned.

a A new well, not yet stoned up. Following section is exposed: Loam, 2 feet; sand, 5½ feet; gravel, 5 feet. Ground level at the well is 12 feet above river level.
b 200 feet south of well No. 8.
c Oct. 12, 1914, had 2.6 feet of water; Oct. 21, had 3.8 feet.

Dug wells ending in stratified drift in Farmington—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
75		Plain	250	14.1	13.3	Chain pump	
76		do	250	30			Rock bottom; fails.
77		do	205	15.9	14.6	Deep-well pump.	Tiled.
78	C. A. Alderman	do	250	18.9	17.6	Chain pump	
78a	do	do	250	16.6	15.4	do	(a).
82		do	240	25.1	24.0	Chain pump	
84		do	205	12.3	11.0	House pump	Unfailing.
84a		do	205	7.4	6.8	Chain pump	Fails.[b]
85		do	200	11.7	10.2	do	
87		do	170	13.3	12.0	do	Do.
88		do	170	14.9	13.5	House pump	
89		do	170	17.1	14.7	Deep-well pump and gasoline engine.	Unfailing.
92		Slope	220	10.1	9.5	House pump	Tiled.
93		Plain	250	30.5	29.8		
96		do	185	14.5	12.1	Pitcher pump	Do.
97		Slope	165	25.4		Two-bucket rig	Fails.
98		do	185	31.0	29.8	Windlass rig	
99		do	190	20.4	17.9	Chain pump	
100	N. H. Fossum	do	200	21.4	17.6	do	For assay see p. 128.
101		Plain	200	14.6	14.0		
102		Slope	215	16.7	12.2	Chain pump	Abandoned.
103		Plain	195	25.3		Two-bucket rig	Abandoned; fails.
104		do	190	9.1	7.8	House pump	
105		Slope	215	25.1	9.9	Windlass rig	Abandoned.
106		do	170	19.5	19.4	do	
107		do	180	25.1	21.8	Two-bucket rig	(c).
108		do	160	9.0	7.9	Chain pump	
108a		do	170	14.5	13.0	Two-bucket rig	(d).
109		do	170	19.4	15.9	Chain pump	Abandoned; unfailing.
111		Plain	190	33.1		Two-bucket rig	Abandoned; fails.
113		do	180	23.4	20.0	do	Tiled; unfailing.
114	Davis	do	175	18.0	12.4	do	Unfailing.
115		do	185	15.1	14.6	Windlass rig	Do.
116		do	175	17.5	11.1	Chain pump	Abandoned; fails.
118		do	165	11.0	9.4	Windlass rig	Fails.
119		do	170	19.2	16.4	Two-bucket rig	Do.

[a] Oct. 12, 1914, had 1.2 feet of water; Oct 21, had 2.4 feet.
[b] 200 feet northeast of well No. 84.
[c] Aug. 19, 1914, had 3.3 feet of water; Oct. 13, had 2.4 feet.
[d] Halfway between wells Nos. 107 and 68.

Driven wells in Farmington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Diameter.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	
2		Valley	215	33			
9		Plain	200		20		
50		do	200	30			Water rather hard.
83		do	200				
84b		do	205	25			(a).
86		do	170		25		
90	Miss Porter's school	do	160				
91		do	165	22.5			(b).
94		do	205	33	30		Working cylinder down 10 feet.
95		do	195	33			
134		do	325	30		6	Fails.

[a] Dug well 110 feet deep with a 15-foot drive pipe; 150 feet north of well No. 84.
[b] Dug well 16.5 feet deep with a 6-foot drive pipe.

Drilled wells in Farmington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
5	American Writing Paper Co.	Plain...	205	430	50	0	125–130	Sandstone.	Have a brass screen above rock; 4-inch air lift.
18	Seth W. Cook..	Slope...	240	92	22	6	3	.....do....	For analysis see p. 128.
39	....	...do....	280	92	....	6	....	.....do....	Water enters at 40 feet.
45	Peck Bros......	...do....	240	57	25	6	10–15	.....do....	For assay see p. 128.
63	....	Plain...	310	152	30	6	80	.....do....	
112	T. H. & L. C. Root.	Slope...	550	187	2 or 3	....	....	....	(a).
125	Miss Porter's school.	...do....	360	480	75	6	40+	Sandstone and shale.	(b).
126	C. C. Cook......	...do....	320	208	....	....	....	....	(c).
128	Wm. S. Miles...	Hilltop..	440	....	....	6	....	Sandstone.	For analysis see p. 128.
131	....	Slope...	360	44	12	6	....	.....do....	Windmill used.
132	Wm. J. O'Meara	Hilltop..	390	173	9	....	....	....	
146	Ed. Kilborn....	Plain...	340	59	....	....	....	Trap......	
147	C. F. Finneman.	...do....	340	41	13	....	....	.....do....	

[a] Drilled through 180 feet of trap and 5 or 6 feet of sandstone.
[b] Two flows were struck, at 425 and 475 feet, respectively; not used.
[c] Water enters at 187 feet.

Springs in Farmington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Remarks.
			Feet.	*°F.*	
51	J. E. Thomas...........	Swamp edge......	180	50	Unfailing; for analysis see p. 128.[a]
80	....	Foot of bank......	290	45	
117	....	At brookside......	180	....	Unfailing.

[a] Improved with a half hogshead; pumped by windmill and distributed from tank by gravity.

QUALITY OF GROUND WATER.

The results of three analyses and three assays of samples of ground water collected in Farmington are given below. Like the other ground waters in the area covered by this paper, those in Farmington are soft, although Nos. 128 and 156 have a total hardness of 178 and 101 parts per million, respectively. While all waters containing less than 200 parts per million of total hardness as calcium-carbonate are considered soft, waters running as high as Nos. 128 and 156 are unusual in the area under discussion. All the waters analyzed are low in mineral content, ranging from 59 to 140 parts per million of total solids, except Nos. 100 and 128, which contain 170 and 291 parts per million, respectively. With the exception of No. 100, which is of the sodium-carbonate type, the waters are calcium-carbonate in chemical character. All are good for boiler use except Nos. 128

and 156, which are classed as fair for boilers on account of the amounts of scale-forming constituents they contain.

So far as the quantity and nature of the mineral matter in solution in these waters are concerned the waters are good for domestic use. The high nitrate and comparatively high chloride of No. 128, however, indicate surface pollution.

Chemical composition and classification of ground waters in Farmington.

[Parts per million; samples collected Nov. 16, 1915; analyzed by S. C. Dinsmore. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 125–127.]

	Analyses.[a]			Assays.[b]		
	c18	51	128	45	100	156
Silica (SiO_2)	10	13	24	....	....	....
Iron (Fe)	.04	Trace.	.04	Trace.	Trace.	0.20
Calcium (Ca)	20	10	45	....	....	....
Magnesium (Mg)	2.9	2.8	16	....	....	....
Sodium and potassium (Na+K) [d]	5.5	5.6	22	2	44	7
Carbonate radicle (CO_3)	.0	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	44	51	126	56	131	134
Sulphate radicle (SO_4)	13	.0	39	Trace.	20	Trace.
Chloride radicle (Cl)	8.0	4.0	23	4	10	4
Nitrate radicle (NO_3)	16	1.5	60	....	....	....
Total dissolved solids	97	59	291	d 70	d170	d 140
Total hardness as $CaCO_3$	d 62	d36	d 178	47	54	101
Scale-forming constituents [d]	74	47	180	60	70	120
Foaming constituents [d]	15	15	59	10	120	20
Chemical character	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3	Na-CO_3	Ca-CO_3
Probability of corrosion [e]	(?)	N	(?)	(?)	N	N
Quality for boiler use	Good.	Good.	Fair.	Good.	Good.	Fair.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Sample collected Nov. 17, 1915.
[d] Computed.
[e] Based on computed value; N=noncorrosive; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

Within the town of Farmington there are two small waterworks which supply Farmington village and Unionville. No. 4 reservoir of the Hartford system is in the southeast corner of the town.

Farmington Water Co.—In the early days the inhabitants of Farmington used wells almost exclusively, but later many small gravity systems which carried water from springs or spring-fed brooks on the hills were constructed in the eastern part of the town. Various kinds of pipe were used—bored logs, tile pipes, lead pipe (both seamed and seamless), and iron pipe. One of the largest of these systems was that of Mr. Wadsworth, which supplied half a dozen families and from which the present system has grown.

The company formally began operations in 1886 but was not incorporated until 1895. In 1892 it was found necessary to build a good-sized reservoir part way up the north slope of Rattlesnake Mountain. A dam 720 feet long and with an average height of 10

feet obstructs a small stream and makes a reservoir covering about 20 acres and with a capacity of 80,000,000 gallons.[51] In 1899 a sand filter covering an area 80 by 100 feet was built, as trouble had been experienced with algal growths in summer. The water is distributed under gravity through about 4 miles of main and is delivered at an average pressure of 65 pounds to the square inch to 33 fire hydrants and 166 private service taps. Most of the people in the village, about 1,000, use the water, and the annual consumption is estimated at 55,000,000 gallons.[52]

Unionville Water Co.—Unionville has been supplied since October, 1893, by the Unionville Water Co. On a small brook in Avon, between Roaring Brook and Farmington River, there are two small reservoirs with a combined capacity of 2,500,000 gallons. The upper is used for storage only, and the lower delivers water by gravity through about 5 miles of main to 35 hydrants and 376 private taps. The pressure ranges from 65 to 85 pounds to the square inch. This system, with a storage capacity of only 2,500,000 gallons on a very small brook, is inadequate for the 1,700 people in Unionville. The Collinsville Water Co. has about the same storage capacity but draws from a much larger stream (Nepaug River) and has an abundant supply for the 2,500 people served. It is highly desirable that some addition be made to the resources of the Unionville system, as water famines occur frequently. There are several brooks which join Farmington River from the southwest near Unionville, and on one or more of them reservoirs could be constructed. The stratified drift in the valley of Roaring Brook, northeast of Unionville, carries a great deal of ground water which could be recovered by means of driven wells, as it is at Plainville. (See p. 177.) This would be more expensive than the present supply, but it would be better to pay the price than to continue in danger of water famines.

GRANBY.

AREA, POPULATION, AND INDUSTRIES.

Granby is near the west end of the northern tier of towns in Hartford County. There are three principal settlements—Granby (or Granby Street), North Granby, and West Granby, which have post offices and stores. Between Granby Street and North Granby are two small groups of houses to which local names are given—Mechanicsville and Pegville. These hamlets are served by the star contract of the stage line connecting North Granby and Granby Street with Granby Station and Tariffville. Another stage line carries mail from

[51] Farmington, Conn., compiled by A. L. Brandegee and E. A. Smith; article on the waterworks by the superintendent, A. R. Wadsworth.

[52] Connecticut Public Utilities Comm. Rept., 1915.

187118°—21—WSP 466——9

Granby Station to Granby Street and West Granby, and also on to East Hartland. There is a fourth hamlet, Hungary, just east of the gap in Manitick Mountain, and a fifth, Bushy Hill, 1½ miles west of Granby Street.

Granby has an area of about 41 square miles, of which about 70 per cent is wooded. The woodlands are mostly restricted to the western part of the town and are deciduous; the woods of the eastern part consist largely of white pine (*Pinus strobus*). There are about 134 miles of roads, of which about 5½ miles are macadam roads. The roads from Granby Station to Granby Street and West Granby and from Granby Street to Goodrichville are parts of the network of State trunk-line roads. There are in addition about 4 miles of roads that have been discontinued.

Granby was part of the town of Simsbury up to 1786, when it was made a separate town. It then included also East Granby, which was cut off and incorporated in 1858. In 1910 Granby had a population of 1,383.

Population of Granby, 1790–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1790	2,595	1840	2,611	1890	1,251
1800	2,735	1850	2,488	1900	1,299
1810	2,696	1860	1,720	1910	1,383
1820	3,012	1870	1,517		
1830	2,733	1880	1,340		

[a] Connecticut Register and Manual, 1915, p. 653.

The loss in the decade from 1850 to 1860 is due to the cession of East Granby. The population reached a maximum in 1820, and lost rather steadily till 1890, since when it has gained slightly. The loss is probably part of the general drift from the agricultural sections of New England to the centers of manufacturing. The recent gain is probably due to the development of the growing of wrapper and binder tobacco. Before the construction of the Farmington Canal in 1827 there was a little manufacturing of metal products, shoes, harness, and silver plate. This has died out, and agriculture is now the principal industry. A great deal of tobacco and considerable amounts of dairy products are shipped each year.

SURFACE FEATURES.

The eastern part of Granby is a part of the central lowland province of Connecticut and is a rolling plain above which rise several prominent hills. The hills of the western half of the town are for the most part about 900 feet above sea level, but one flat-topped hill in the southwest corner rises to 1,166 feet. The lowest point in Granby is where Salmon Brook crosses into East Granby, at an elevation of only 155 feet above sea level, so the total range is a little over 1,000 feet.

The highland has a fairly straight eastern front, past the foot of the northern part of which Dismal Brook flows southward to North

Granby. South of this point the front is more thoroughly dissected, and where Salmon Brook enters the lowland it is very much broken down. The southern part of the highland front is partly obscured by the Barndoor Hills and their southward prolongations, which though they belong in the lowland are nearly as high and rugged as the adjacent highland.

The lowland of Granby has several divisions, the most characteristic of which is the plain of Salmon Brook and its North Branch. This plain is a mile or two wide and ranges in elevation from 160 to 300 feet above sea level. A mantle of stratified drift with a maximum thickness of at least 75 feet covers the plain. Above it rise gently rounded hills with sandstone cores and a mantle of till having a maximum thickness of perhaps 40 feet. These hills attain elevations of 400 to 500 feet above sea level. The sandstones and shales underlying the lowland are softer than the crystalline rocks of the highland and have therefore been worn down to their present lowness. Associated with the sandstone and shale is a sheet of trap rock which crops out in the Barndoor Hills and in Manitick Mountain and gives them their topographic prominence. The trap sheet has been broken by faults which have caused the gaps in these hills.

The soil of the sand plains is highly porous. It is very suitable for raising tobacco and in a natural state had a forest consisting in large part of white pines. Plate VI, *B*, shows a stand of white pine (*Pinus strobus*) near Granby Street.

Two areas in Granby contain a number of eskers; one is west of West Granby, and one is in the northwest corner of the town and overlaps into Hartland. The eskers are winding ridges of stratified drift, 10 to 30 feet high, and from a few hundred yards to half a mile in length. They were deposited in channels or fissures at the bottom of the ice sheet and have been left by the melting away of the ice.

A ridge of till a quarter of a mile long, 50 to 150 feet wide, and 10 to 25 feet high forms a conspicuous topographic feature just north of well No. 45 (Pl. III). During the time that the great ice sheet was melting back from this region there were interruptions and even reversals of this movement. It is probable that at such a time this ridge was built up as a lateral moraine by the temporarily advancing ice.

The southern half of Granby is drained by Salmon Brook and its tributaries. Above West Granby these streams are steep and swift but have a few slowly flowing reaches with small flood plains. North Branch of Salmon Brook, formed by the junction of Dismal Brook and East Branch at North Granby, drains the northern half of the town. These streams have gentle gradients for the greater part of their courses. On October 6, 1915, rough measurements were made of the discharge of these streams just above their juncture. North Branch showed a flow of about 9 second-feet and Dismal Brook about 3 second-feet. A lesser tributary a mile east of North Granby on the same day was flowing about 1 second-foot.

WATER-BEARING FORMATIONS.

Schist.—Western Granby is underlain by the mica schist known as the Hoosac schist. It is of light to medium gray color and consists essentially of mica and grains of quartz and in some places a little feldspar, garnet, or other accessory mineral. The mica flakes are arranged in a roughly parallel manner and by reason of their cleavability make the rock fissile. Water is carried to a slight extent by the minute openings between the mica flakes but more abundantly in the larger fractures and openings. Mr. Stevens's well (No. 40, Pl. III) was drilled below the bottom of an old dug well that was 18 feet deep, 10 feet in solid rock. The principal supply enters the drill hole at a depth of 65 feet, and there is another smaller flow at a greater depth. The water is under sufficient head to make it rise into the dug portion of the well, from which it is carried by a siphon to the house, 40 feet lower on the hillside. No other drilled wells in schist were found, but undoubtedly such wells could be successfully put down somewhere on every farm in the western part of the town.

Sandstone and trap.—Red sandstones and shales, dipping uniformly to the east with a slope of 15° to 20°, underlie the eastern half of Granby. These were deposited as sands and clays in the great valley that occupied central Connecticut in Triassic time. The deposition was thrice interrupted by the quiet outpouring of lava, which eventually became the trap sheets of Talcott and East Granby mountains. At one time, also, there was forced into the sediments the lava which now forms the sheets of the Barndoor Hills and Manitick Mountain. The tilting of the rocks occurred subsequently and was accompanied by extensive faulting and fracturing, in both the sedimentary and the volcanic rocks. The topographic form of the trap sheet is disadvantageous for the retention of ground water, as it allows water to seep away readily. Seven wells drilled into sandstone were visited. Their average depth is 112 feet, and the average reported yield of four of them is 6 gallons a minute.

Till.—Till is the more abundant surface rock in Granby and covers virtually all of the highland as well as the parts of the lowland more than 260 to 300 feet above sea level. It is a layer of rock rubbish composed of finely ground rock flour with clay, silt, sand, pebbles, and boulders, all thoroughly mixed together. Below a certain depth, which varies from place to place and also with the seasons, the minute pores of the till are full of water, which will seep slowly into wells dug deep enough. On account of the seasonal fluctuation of the water level some wells in till may fail in times of drought. Measurements were made of 42 wells dug in till in Granby. The depth to the water level in them ranged from 0.6 foot in well No. 82 (see Pl. III) to 24.4 feet in well No. 35; the average depth to water was 9.8 feet. Inquiries were made as to the reliability of 34 of these wells; 24 were said to be nonfailing and 10 were said to fail. In well No. 50 there is

indicated a fluctuation of at least 14 feet, for although it had that much water in it when measured (Oct. 13, 1915) it is said to fail.

Stratified drift.—The stratified-drift deposits are very different from the till. Their materials are the thoroughly washed and sorted materials of the till and are relatively free of the very fine and the very large constituents. In these sands and gravels the pores are larger and better connected than in the till, so the supply of water to wells is more abundant. The plainlike deposits of stratified drift are the best of water bearers, but the supply in the eskers is neither abundant nor reliable. Measurements of 31 wells dug in the stratified drift were obtained in Granby. The depth to the water level averaged 10.3 feet and ranged from 3.1 feet in well No. 57 (see Pl. III) to 37.2 feet in well No. 69. Six of these wells were said to fail and 14 to be nonfailing; the reliability of the remaining wells was not ascertained.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Granby.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1	....	Slope...	530	21.5	19.9	Windlass rig........	Abandoned; fails.
4	....	...do.....	705	18.4	12.1	Chain pump........	
5	....	...do.....	645	18.1	12.2	House pump........	Unfailing.
6	....	...do.....	645	21.9	17.4	Windlass rig........	Fails.
7	....	...do.....	490	24.8	9.1	House pump........	Unfailing.
8	....	...do.....	430	10.8	7.4	Chain pump........	Do.
10	....	...do.....	425	22.4	11.7	.....do..............	Fails.
11	....	...do.....	445	14.2	6.3	.....do..............	Unfailing.
12	....	...do.....	430	12.1	7.2	.....do..............	Do.
13	....	...do.....	410	16.7	11.8	Deep-well pump and chain pump.	Fails.
14	....	...do.....	870	9.4	3.2	(a)..................	
15	....	...do.....	875	13.3	6.5	(a)..................	Unfailing.
16	....	...do.....	620	15.5	5.5	Windlass rig........	
20	....	Plateau.	1,025	15.1	6.4	.....do..............	Do.
21	....	Slope...	600	18.5	11.6	House pump........	Do.
22	....	Hilltop..	980	13.9	8.6	Chain pump........	
23	....	Slope...	925	16.5	7.6	Two-bucket rig.....	
24	....	...do.....	880	9.6	3.8	Chain pump	Rock bottom; unfailing.
25	....	...do.....	710	19.8	13.7	.....do..............	
26	....	...do.....	560	18.5	13.9	Windlass rig........	Unfailing.
27	....	...do.....	1,160	17.4	12.6	.....do..............	
28	....	...do.....	1,085	25.9	13.8	Deep-well pump....	Do.
29	....	...do.....	850	14.4	7.3	Chain pump........	Do.
30	....	...do.....	600	8	4	Gravity system.....	Do.
31	....	...do.....	630	16.2	8.5	Chain pump........	Do.
32	....	...do.....	1,110	14.3	6.3	Windlass rig	Do.
33	....	Hilltop..	1,120	22.3	18.1	.....do..............	Fails.
34	....	Plain...	370	13.1	11.5	Sweep rig..........	Do.
35	....	Slope...	560	29.2	25.4	Windlass rig........	Do.
36	Wm. V. Goddard	...do.....	460	15.4	5.9	Chain pump........	Unfailing; rock bottom; for assay see p. 135.
37	....	...do.....	410	10.0	7.2	Windlass rig........	Unfailing.
41	....	Plain...	300	15.0	9	Deep-well pump....	Do.
42	....	...do.....	315	11.5	6.7	Windlass rig........	Do.
46	C. M. Beman....	Slope...	380	12.2	8.1	Chain pump........	Unfailing; for analysis see p. 135.
49	....	...do.....	330	26.7	5.1	Windlass rig........	
50	....	Plateau.	445	31	15	Windmill...........	Unfailing.
62	....	Plain...	340	18.0	13	....	Do.
76	....	Slope...	390	12.6	3.4	Chain pump........	Do.
81	....	...do.....	325	14.1	9.5	Two-bucket rig.....	Fails.
82	....	...do.....	325	9.8	.6	Gravity system.....	Fails; temperature, 57° F.
83	....	...do.....	325	16.9	10.7	Windlass rig........	Unfailing.

a No rig.

Dug wells ending in stratified drift in Granby.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
2	....	Plain...	480	8.7	6.7	Pitcher pump.......	
9	....	...do....	415	9.4	6.3	Windlass............	Unfailing.
17	....	Slope...	685	....	16.0	Pitcher pump.......	Do.
18	H. S. Parmelee..	...do....	655	7.7	6.5	Siphon ram.........	Unfailing.
19	....	Plain...	700	12.2	8.8	Windlass............	
38	....	...do....	350	10.5	8.2	Windlass and house pump.	Fails.
39	....	...do....	345	15.7	10.2	....	Unfailing.
43	Mary S. Miller...	Slope...	310	15.0	11.0	Windlass............	Do.
44	....	...do....	280	13.8	7.0	Deep-well pump....	Fails.
45	....	...do....	315	11.4	5.2	Windlass............	Do.
47	....	...do....	250	11.5	8.4	.....do..............	
48	Parsonage.......	...do....	280	23.6	13.3	House pump........	Unfailing; for assay see p. 135.
52	....	...do....	255	10.5	6.3	Windlass............	Unfailing.
53	....	Plain...	260	12.2	4.4	Chain pump........	Do.
55	....	...do....	250	10.0	3.7	.....do..............	Do.
56	....	...do....	210	24.1	14.5	Windlass............	Fails.
57	....	...do....	260	13.1	3.1	(a)..................	Unfailing.
58	....	Slope...	230	20.6	13.6	Windlass............	Fails.[b]
59	....	Plain...	235	12.7	8.7	Chain pump........	Unfailing.
65	....	...do....	310	41.0	....	....	Driven well.
66	....	...do....	290	23.9	16.4	Two-bucket rig.....	
68	....	...do....	190	11.2	8.0	Chain pump........	Unfailing.
69	....	...do....	195	37.6	37.2	Windlass............	
70	....	...do....	225	11.2	7.5	.....do..............	
72	....	Hilltop..	265	15.0	5.0	(c)..................	Do.
74	....	Slope...	215	12.5	10.2	Windlass............	Rock bottom; unfailing.
75	....	Plain...	155	9.6	....	....	Fails.
78	....	...do....	230	17.6	11.1	Chain pump........	Do.
84	....	Slope...	200	19.1	12.1	Windlass............	
85	....	...do....	190	21.0	14.5	.....do..............	
86	....	...do....	180	19.8	18.6	.....do..............	
87	....	Plain...	235	12.6	10.6	.....do..............	

[a] 8-foot diameter. Pumped with a gasoline engine.
[b] Rock bottom. Water enters through drill holes in the bottom. When the well fails the supply may be restored by cleaning out the drill holes.
[c] No rig.

Drilled wells in Granby.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
40	A. A. Stevens..	Slope...	440	114	8	6	1½	Schist.......	For analysis see p. 135.[a]
51	A. F. Batayte..	Plain...	280	86	15	6	12	Sandstone...	$2 a foot.
54	A. B. Wells....	...do....	250	90	23	6	....	.....do......	
67	G. A. Smith....	...do....	290	50	28	....	....	.....do......	
71	....	Slope...	210	130 (?)	17 (?)	....	5 (?)	.....do......	
73	Wm. Myers....	...do....	210	105	75	6	....	.....do......	
79	F. L. Spring....	Hill.....	300	206	....	6	2	.....do......	
80	L. C. Spring....	Slope...	260	114	48	6	5	.....do......	

[a] Well is higher than the house and the water is carried in by a siphon. Principal supply from a fissure at a depth of 65 feet.

Springs in Granby.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	°*F.*	*Gallons.*	
3		Slope	640	49	30	Operates 3 rams; unfailing.
60		do	260	56		Piped to house.
61	Almon V. Godard	do	360	52		Piped to house; in red sandstone.
64		do	300	56		Piped to house.
77		do	265	49		Do.

QUALITY OF GROUND WATER.

The results of two analyses and two assays of samples of ground water collected in Granby are given below. The waters are of the calcium-carbonate type and are low in mineral content, ranging from 51 to 130 parts per million of total dissolved solids. They are all very soft and are classified as good for both domestic and boiler use.

Chemical composition and classification of ground waters in Granby.

[Parts per million; samples collected Dec. 4, 1915; analyzed by S. C. Dinsmore. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 133-134.]

	Analyses.[a]		Assays.[b]	
	[c]40	46	[d]36	48
Silica (SiO_2)	14	17		
Iron (Fe)	.46	.05	Trace.	Trace.
Calcium (Ca)	7.4	16		
Magnesium (Mg)	.7	4.3		
Sodium and potassium (Na+K)[e]	[f]6.8	4.3	5	18
Carbonate radicle (CO_3)	.0	.0	0	0
Bicarbonate radicle (HCO_3)	29	39	34	61
Sulphate radicle (SO_4)	7.8	3.7	15	20
Chloride radicle (Cl)	1.2	22	4	15
Nitrate radicle (NO_3)	.25	Trace.		
Total dissolved solids	51	82	[e]73	[e]120
Total hardness as $CaCO_3$	[e]21	[e]58	39	57
Scale-forming constituents [e]	37	71	55	70
Foaming constituents [e]	18	12	10	50
Chemical character	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion [g]	N	(?)	(?)	(?)
Quality for boiler use	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59-61.
[b] Approximations; for methods used and reliability of results, see pp. 59-61.
[c] Analyzed by Alfred A. Chambers, U. S. Geol. Survey.
[d] Sample collected Dec. 3, 1915.
[e] Computed.
[f] Determined.
[g] Based on computed value; N=noncorrosive; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

The village of Granby Street is supplied with water by the Salmon Brook Water Co. Water is pumped from a small tributary of Salmon Brook and is delivered through a mile of main pipe to 62 service taps. Most of the people in the area covered by the service are supplied, and the water is used solely for domestic and farm purposes.

HARTLAND.

AREA, POPULATION, AND INDUSTRIES.

Hartland is the most northwesterly town in Hartford County and lies next to the Massachusetts boundary. The two largest settlements are East Hartland and West Hartland, which are east-central and west-central in position. There are also hamlets at Hartland (Hartland Hollow) and North Hartland, in the deep valley between the two villages, and at Centerhill, south of West Hartland. There are post offices at all these places and stores at East and West Hartland. A stage line with a star contract connects East Hartland with Granby Station, on the Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad. Another stage runs to the other settlements in Hartland from New Hartford, on the Central New England Railway and the New Hartford branch of the Northampton division. The town has an area of 34 square miles, about three-fourths of which is wooded. About 96 miles of roads are maintained by the town, and about 16 miles have been legally abandoned. None of the roads are metaled, but in time a State trunk-line road will be built across the town.

The territory of Hartland was originally held by certain financiers in Hartford, and its name was chosen for this reason. The town has not changed in organization or extent since its incorporation in 1761. The population in 1910 was 544. Since 1800 a loss in population has been shown at every census except that of 1900. The gain of that decade is said by Mr. David N. Gaines, the postmaster at East Hartland, to have been due to the coming in of a few men for temporary employment in portable sawmills, and the strictly resident population decreased. Hartland is so remote from the railroad and its climate is so harsh that many of the residents emigrated to better farming country and particularly to Ohio. This emigration started at the beginning of the nineteenth century, and it is said that on Thanksgiving Day, 1802, 17 families comprising 117 people left for Ohio.

Population of Hartland, 1756–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1756	12	1820	1,254	1880	643
1774	500	1830	1,221	1890	565
1782	961	1840	1,060	1900	592
1790	....	1850	848	1910	544
1800	1,318	1860	846		
1810	1,284	1870	789		

[a] Connecticut Register and Manual, 1915, p. 654.

At no time has manufacturing thrived in Hartland, and agriculture, especially stock raising, has been the chief industry.

SURFACE FEATURES.

Hartland is a high plateau that is only slightly dissected except for two deep valleys that trench it. These features are shown in the topographic and geologic section across the town given in figure 23 and indicated on Plate II by the line *A–A′*. The plateau ranges in elevation from 1,160 to 1,340 feet above sea level. Into it are cut a number of broad but shallow valleys, and on it stand a few higher hills. Several such hills in the northwest corner of the town are over 1,400 feet above sea level, the highest being about 1,460 feet.

The valley of East Branch of Farmington River, known locally as Hartland Hollow, cuts the town into eastern and western parts. In flowing across the town East Branch drops from an elevation of 630 feet to 475 feet above sea level. The steep valley walls are 500 to 700 feet high and are very impressive scenic features. The valley was in existence in preglacial time but was overdeepened by the glacier. Half a mile south of Hartland Hollow there is a lateral moraine, a mass of till plastered against the valley wall by the ice. The valley has a flat floor a quarter to three-quarters of a mile wide, formed of stratified drift washed in since the recession of the glacier. In part this plain is bounded by terraces of stratified drift 15 to 25 feet high. The relations of the rock wall, the lateral moraine, the flat valley floor, and the terraces are shown in figure 24.

The valley of West Branch of Farmington River for about 2 miles of its length lies in the southwest corner of Hartland. This valley has been modified by glacial erosion, but not to so great a degree as that

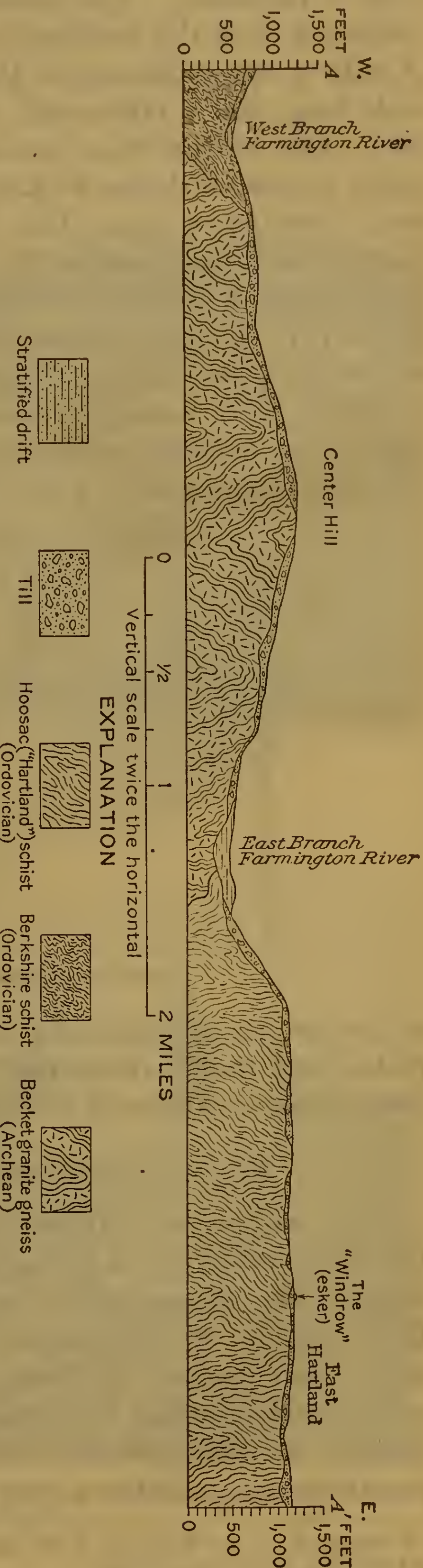

FIGURE 23.—Profile of Hartland.

of East Branch. It is not so deep and has a narrower floor and a narrower area of stratified drift.

There are a number of eskers and esker-like deposits in the eastern half of Hartland. Two eskers, a quarter and half a mile long, run eastward from the northeast corner of the town and end in Granby. A mile or two southwest of these are three eskers, each a quarter of a mile long, and a mile south of East Hartland are two more of like size. One of the finest eskers in the State runs southward from a point a mile southwest of East Hartland and is known locally by the very descriptive name The Windrow. The length of its sweeping S curve is three-quarters of a mile, its width is from 50 to 100 feet, and its height from 12 to 30 feet. The crest is narrow and unbroken. Plate VII, *A*, is reproduced from a photograph taken near the south end of the esker ridge and shows its serpentine character.

On Mr. A. C. Banning's farm, 1¼ miles northwest of East Hartland, there is an excellent example of a perched boulder, a photograph of which is reproduced in Plate VII, *B*. Boulders of this type, carried

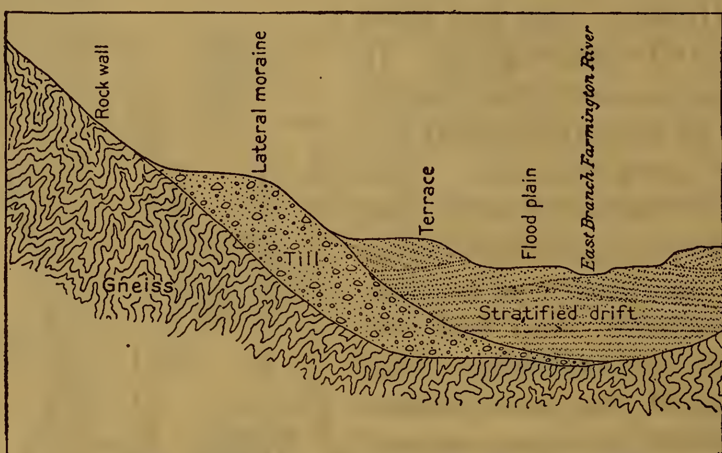

FIGURE 24.—Diagrammatic profile of Hartland Hollow.

by the glacier, rounded and smoothed by being ground against other rocks, and finally deposited far from their original position, constitute clear evidence of glaciation.

WATER-BEARING FORMATIONS.

Schist and gneiss.—There are three kinds of bedrock in Hartland—the Hoosac schist, the Becket granite gneiss, and the Berkshire schist. The Hoosac schist underlies that part of the town east of East Branch of Farmington River.[53] It is a typical gray mica schist, and consists of flakes of mica in part infolding granules of quartz and of other less abundant minerals. The mica flakes are roughly parallel and allow the rock to split readily. The Becket granite gneiss underlies a strip 2 to 3 miles wide west of East Branch.

[53] Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 7, 1907.

A. THE WINDROW, AN ESKER NEAR EAST HARTLAND.

B. PERCHED GLACIAL BOULDER OF PEGMATITE RESTING ON A LEDGE OF SCHIST NEAR EAST HARTLAND.

It is a grayish rock composed of lighter bands of quartz and feldspar alternating with darker bands in which biotite is predominant. In places it grades into a schist which is hard to distinguish from either the Hoosac or the Berkshire schist. The Berkshire schist underlies a strip half a mile to 1½ miles wide along the western boundary of Hartland. Typically it is a gray or gray-green mica schist like the Hoosac schist in composition, though a little more subject to weathering. All three of these formations have had thin sheets and dikelets of quartz and pegmatite injected into them, and they are cut by numerous joints and fissures.

The water-bearing features of these three kinds of bedrock are similar. Water which has fallen as rain and soaked into the soil slowly finds its way into the maze of interconnecting joints and fissures of the bedrock. Wells drilled into the rock are rather certain of cutting one or more such fissures within a reasonable depth. There are five such wells in Hartland—one in the Berkshire schist, and two each in the Becket granite gneiss and the Hoosac schist. Their average depth is 231 feet.

Till.—There is a mantle of till over the whole town except for the valley-floor and esker deposits of stratified drift and the scattered ledges of bare rock. The till has a maximum thickness of more than 30 feet and consists of an unassorted and unstratified mass of rock flour, clay, silt, sand, pebbles, and boulders deposited by the scraping and plowing of the glacier. It yields moderate supplies of water to dug wells. Thirty-five such wells were measured in Hartland, and the depth to water was found to average 9.7 feet and to range from 2.7 feet in well No. 23 (see Pl. III), to 19.8 feet in well No. 46. Of the 30 wells whose reliability was ascertained 20 were said always to have enough water for domestic needs and 10 were said to fail.

Stratified drift.—Only five wells in stratified drift in Hartland were measured, and these were all on the valley-floor areas. Their depth averaged 11.8 feet and ranged from 8.5 feet in well No. 32 to 18.8 feet in well No. 31. Only one of these wells is said to fail; the others are reliable in all seasons.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Hartland.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
2		Slope	1,085	21.5	11.9	House pump	Unfailing.
3		Plateau	1,105	22.4	9.9	do	Fails.
4		do	1,275	13.1	6.0	Windlass rig	
5		Slope	1,135	16.5	9.1	Chain pump	Unfailing.
7		do	1,080	21.2	9.1	do	Fails.
8		do	1,260	19.3	9.9	House pump	Do.
9	Thos. Booth	do	1,180	17.3	10.1	Pitcher pump	Fails; for analysis see p. 141.

Dug wells ending in till in Hartland—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
10		Slope	1,330	14.4	5.9	Chain pump	Unfailing.
11	M. B. Foster	do	1,205	15.0	3.0	do	Do.
14	Wm. Martin	Plateau	1,180	16.8	12.0	Windlass rig	Unfailing; for assay see p. 141.
16		do	1,130	15.6	5.2	House pump	
17		do	1,210	16.0	8.5	Windlass rig	Unfailing.
18	A. C. Banning	do	1,190	21.4	13.9	Two-bucket rig	Fails; for assay see p. 141.
20		do	1,215	13.8	8.6	House pump	Unfailing.
21		Hilltop	1,040	16.7	9.9	Pitcher pump	Do.
22		do	1,060	11.1	4.3	(a)	Fails.
23		Slope	1,015	8.7	2.7	do	Unfailing.
24		do	930	17.0	10.2	Windlass rig	Do.
26		do	740	13.2	11.2	do	Fails.
27		do	1,020	12,9	11.6	do	
28		Hilltop	1,095	9.7	7.5	(a)	Unfailing.
29		Slope	1,185	31.8	15.3	Windlass rig	Do.
34		Plateau	1,150	15.4	10.1	Two-bucket rig	Fails.
35		do	1,220	12,3	8.8	Windlass rig	Do.
36		do	1,225	13.6	5.0	do	
37	Store	do	1,225	17.6	9.5	Chain pump	Unfailing; for assay see p. 141.
38		do	1,220	16.1	8.5	(a)	Unfailing.
39	D. N. Gaines	do	1,220	22.4	18.7	Deep-well pump	Fails.
41		do	1,110	11.6	5.2	Windlass rig	Unfailing.
42		do	1,100	14.3	6.6	do	Do.
43		Slope	1,185	21.4	15.8	Deep-well pump	Do.
44		do	1,005	20.0	18.2	Two-bucket rig	
45		do	1,030	19.7	12.6	do	Do.
46		do	1,100	27.5	19.8	Windlass rig	Do.
47		do	1,080	11.9	5.3	do	Do.

a No rig.

Dug wells ending in stratified drift in Hartland.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
15		Slope	630	18.6	12.5	(a)	Unfailing.
30		do	540	13.4	9.6	Deep-well pump	Do.
31		do	550	21.7	18.8	Windlass	Fails.
32		do	540	16.0	8.5	Chain pump	Unfailing.
33		do	530	12.9	9.6	Sweep rig	Do.

a No rig.

Drilled wells in Hartland.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
1	Howell	Hilltop	1,225	336	15 or 20	8	(a)	Schist	Windmill.
6	do	Plateau	1,220	288	10	8	9	Gneiss	Do.
12	M. B. Foster	Slope	1,135	220		6		do	Do.
19	Stephen Caplan	Plateau	1,215	226	24	6	2½	Schist	
40	F. C. Gould	do	1,225	86	25	6	2½	do	For analysis see p. 141.

a Strong flow.

Springs in Hartland.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*°F.*	*Gallons.*	
13	....	Slope...	1,220	53	1/3	Gravity system.
25	....	...do.....	770	49	....	
48	....	...do.....	980	45	....	Gravity system to horse trough.

QUALITY OF GROUND WATER.

Below are given the results of two analyses and three assays of samples of ground water collected in Hartland. The waters are of the calcium-carbonate type except Nos. 9 and 14, which are calcium-chloride and sodium-chloride waters, respectively. All the waters are low in their content of total dissolved solids except No. 14, which according to the assay contains 300 parts per million of solids. They are all soft waters; No. 14 is the hardest of those analyzed for Hartland. All except No. 40 are good for domestic use; No. 40 has been rated as fair in this regard on account of its high iron content, which would probably give trouble in cooking, cause rust spots in the washing of clothes, and stain porcelain ware. No. 14 has been classified as fair for boiler use on account of its rather high content of foaming constituents; all the other waters analyzed are good for boilers.

Chemical composition and classification of ground waters in Hartland.

[Parts per million. Samples of No. 40 (analysis) and Nos. 18 and 37 (assays) collected Dec. 3, 1915; No. 9 (analysis) Nov. 16, 1915; and Nos. 12 and 14 (assays) Nov. 26, 1915. Analyzed by S. C. Dinsmore. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 139–140.]

	Analyses.[a]		Assays.[b]		
	9	40	14	18	37
Silica (SiO_2)	13	17	....	....	....
Iron (Fe)	.04	1.5	Trace.	Trace.	Trace.
Calcium (Ca)	16	7.5	....	....	....
Magnesium (Mg)	4 5	3 0	....	....	....
Sodium and potassium (Na+K)[c]	8.5	6.4	58	2	8
Carbonate radicle (CO_3)	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	24	44	112	24	29
Sulphate radicle (SO_4)	9.4	5.7	15	Trace.	Trace.
Chloride radicle (Cl)	17	2.0	101	3	12
Nitrate radicle (NO_3)	29	Trace.	....	....	....
Total dissolved solids	119	67	[c] 300	[c] 40	[c] 59
Total hardness as $CaCO_3$	[d] 58	[d] 31	135	19	25
Scale-forming constituents [c]	68	44	150	35	40
Foaming constituents [c]	23	17	160	10	20
Chemical character	Ca-Cl	Ca-CO_3	Na-Cl	Ca-CO_3	Ca-CO_3
Probability of corrosion [d]	(?)	N	(?)	N	(?)
Quality for boiler use	Good.	Good.	Fair.	Good.	Good.
Quality for domestic use	Good.	Fair.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Computed.
[d] Based on computed value; N=noncorrosive; (?)=corrosion uncertain.

HARWINTON.

AREA, POPULATION, AND INDUSTRIES.

Harwinton is near the middle of the eastern boundary of Litchfield County, and lies between Thomaston and Torrington and midway between Winsted and Waterbury. For the most part it is a rolling plateau, but its western margin is in the deep valley of Naugatuck River. The principal settlement is Harwinton, locally called the "Center," at which there is a store. Campville and East Litchfield are small settlements along Naugatuck River and are partly in Litchfield and partly in Harwinton. At Campville there is a post office, but the rest of the town is served by rural delivery. The Naugatuck division of the New York, New Haven & Hartford Railroad follows the west shore of the river past Harwinton and has stations at Campville and East Litchfield.

Harwinton has an area of 31 square miles, of which 70 per cent is wooded. There are 96 miles of roads, including 4 miles of State trunk-line macadam road along the Naugatuck. There are in addition 16 miles of roads which have been legally discontinued.

Harwinton was incorporated in 1737 and has suffered no change of organization or territory since. The name is said to have been made by combining syllables from the names of the towns from which the first settlers came, Hartford, Windsor, and Farmington. As shown by the table below the population grew steadily till 1810, and from then on fell off till 1890, owing to the tendency to emigrate to manufacturing centers and to better farming country in the West. Since 1890 there has been a fair growth of population, which seems to be due to the overflow of operatives from the active manufactories of Torrington. The principal industry has always been agriculture. Of late there has been some tendency toward the development of country places in Harwinton.

Population of Harwinton, 1736–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1736	100	1800	1,481	1860	1,044
1737	161	1810	1,718	1870	1,044
1756	250	1820	1,500	1880	1,016
1774	1,015	1830	1,515	1890	943
1782	1,215	1840	1,201	1900	1,213
1790	1,367	1850	1,175	1910	1,440

[a] Figures up to 1790 from Chipman, R. M., History of Harwinton; from 1800 to 1910 from Connecticut Register and Manual, 1915, p. 654.

SURFACE FEATURES.

Harwinton comprises two topographic elements, a dissected plateau and a deep valley bordering it on the west. From the top of the highest residual hill on the plateau, at an elevation of 1,120 feet, to

the lowest point in the town, where Naugatuck River enters Thomaston, at an elevation of 415 feet above sea level, there is a total relief of 705 feet. The plateau is now marked by numerous flat hilltops 1,050 to 1,100 feet above sea level. The plateau is believed to be part of one of a series of marine terraces carved by wave action during a period of submergence. The emergence of the land comprised rapid uplifts separated by longer periods of rest during each of which a more or less perfect terrace was cut. From the hill between wells Nos. 61 and 62 (see Pl. III) can be seen the front of the next higher terrace, which lies to the northwest, as is shown by the photograph reproduced in Plate IV, *A*. In the foreground is the top of the dissected terrace.

Leadmine Brook, which joins Naugatuck River 1½ miles north of Thomaston, flows southward across Harwinton, and with its tributaries drains most of the town. Its gradient is fairly uniform except for a stretch a quarter of a mile long in which it makes 80 feet of its total drop of 350 feet in crossing Harwinton. Poland River, with Powder Brook, its principal headwater, drains the southern half of the eastern edge of the town and is part of the collecting system of the Bristol waterworks. A strip along the west boundary of the town is drained by a number of small brooks that empty into the Naugatuck. A number of float measurements were made on streams in Harwinton, and the results are given in the following table:

Float measurements in Harwinton.

Stream.	Location.	Date.	Flow.
			Sec.ft.
West branch of Leadmine Brook	Just south of Torrington town line	Aug. 19, 1915	1.6
Unnamed brook	500 feet west of well No. 59	July 26, 1915	.6
Do	do	July 27, 1915	.5
Do	do	Aug. 6, 1915	[a] 2.8
Do	¾ mile north of well No. 69	July 27, 1915	.5
Do	Below pond, east of spring No. 52	July 28, 1915	.04
East branch of Leadmine Brook	West-southwest of well No. 58	do	1.1
Leadmine Brook	¼ mile west of well No. 55	July 25, 1915	[b] 1.5
Do	do	July 30, 1915	7.0
Do	do	Aug. 5, 1915	[a] [b] 25

[a] After a rain. [b] Estimated, not measured.

WATER-BEARING FORMATIONS.

Schist and gneiss.—The bedrock of Harwinton has been divided into four formations, each of which has lithologic characters peculiar to it and serving to differentiate it from the others.[54]

Underlying an area a mile wide and 3 miles long, in the middle of which Leadmine Brook flows, is a mass of gneiss which has been called the Thomaston granite gneiss because of its good exposures in the

[54] Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 7, 1907.

town of that name. It is a fine-grained light-colored granite, composed of quartz, feldspar, and black mica, which has locally acquired a gneissic structure through metamorphism. It is probable that the intrusive masses of this rock are related in origin to the thin sheets and dikelets which are so abundant in the schistose rocks of western Connecticut.

Surrounding this granite gneiss area and including most of the rest of the town is a gneiss of complex origin, known as the Waterbury gneiss. This rock was probably formed by the injection into the Hoosac schist of innumerable sheets and dikes attaining thicknesses of 10 to 12 feet. Because of the great range in the relative amounts of the original schist and of the material added by intrusion, the rock ranges from a mica schist to a gneissoid granite.

In the northwest corner of the town there is a triangular area $3\frac{1}{2}$ miles long on the Torrington town line and $2\frac{1}{2}$ miles on Naugatuck River, the northeast half of which is underlain by the Becket granite gneiss and the southwest half by the Berkshire schist. The Berkshire schist, where typically developed, is composed essentially of quartz and mica (both black and white), with lesser amounts of such minerals as garnet and staurolite. The mica flakes are roughly parallel in position and give the rock its laminated, cleavable character. There are varieties in which a little feldspar is found and which approach gneiss in texture. Other varieties are cut by many quartzose and granitic intrusions. The Becket gneiss, where typically developed, is a banded gray rock composed of layers rich in quartz and feldspar alternating with layers high in mica. The degree of segregation of the materials and the amount of mashing the rock has undergone vary widely, so that some parts are almost free of schistose or gneissic structure and are granitic, others are gneissic, and still others are schistose.

The water-bearing conditions of these four rocks are essentially the same. The rocks are so dense that there is little or no water in pores, and whatever water they may contain is in cracks and fissures, into which it has percolated from the overlying mantle of soil. The fissures and cracks were formed by the crushing and jolting to which the rocks have been subjected and are much more abundant and open near the surface than they are farther down. Only one drilled well was found in Harwinton, that of Mr. H. W. Ackerson, in the Waterbury gneiss near Harwinton village. It is probable that equal success would be attained in drilling elsewhere in the town.

Till.—Most of the bedrock of Harwinton is covered by a mantle of till which has a maximum thickness of perhaps 40 feet, though this extreme is attained in but few places. This mantle consists of all the varied débris pushed and dragged along by the glacier and finally deposited in a thoroughly mixed and unstratified condition. The

finest constituents, rock flour and clay, bind together the coarser grains, sand, pebbles, and boulders and make a very tough deposit for which the colloquial name "hardpan" is very appropriate. Despite its toughness and compactness there is considerable pore space in the till, so that it holds a good deal of water which has fallen as rain. Wells dug into the till allow the ground water to seep into them and if deep enough are in general reliable. The average depth to water in 116 such wells measured in Harwinton was found to be 10.3 feet and the range from 1.8 feet in well No. 39 to 40 feet in well No. 90. (See Pl. III.) In well No. 36 a fluctuation of 17.7 feet was noted, for although the well had 17.7 feet of water in it when it was measured (Aug. 20, 1915), it is said to fail. The reliability of 92 of these wells was ascertained; 40 were said to fail and 52 were said to be nonfailing.

Stratified drift.—The deposits of stratified drift in Harwinton are restricted to the parts of the valley floors where the streams are not too rapid. These deposits were formed in large part by the washing and reworking of the till. The finer materials have been removed and the coarser laid down as clean, porous sands and gravels, in the places where the streams have been forced to drop their loads by sluggishness. Very good water supplies may be developed in deposits of this kind. Measurements were made of eight wells dug in stratified drift in Harwinton. The depth to the water table ranged from 5.9 feet in well No. 100 (Pl. III) to 21.6 feet in well No. 74 and averaged 12.5 feet. Two of these wells were said to fail, and five were said to be nonfailing; the reliability of the other well was not ascertained.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Harwinton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
2	....	Slope....	725	16.1	7.7	Chain pump.........	Unfailing.
3	....	...do.....	720	15.9	2.8	......do................	Fails.
4	....	...do.....	690	13.8	9.2	......do................	Unfailing.
5	....	Swale...	795	16.0	6.3	......do................	Fails.
6	....	Slope....	840	19.5	10.9	Windlass rig..........	Unfailing.
7	....	Plateau.	945	15.1	8.5	Chain pump.........	
8	....	Slope....	940	25.5	14.0	Deep-well pump....	Do.
9	....	...do.....	985	19.8	6.8	House pump.........	Fails.
10	....	...do.....	770	20.4	16.9	Windlass rig..........	
11	....	...do.....	890	13.3	4.9	Deep-well pump....	Do.
12	....	...do.....	885	18.5	8.5	Windlass rig..........	Unfailing.
13	....	...do.....	800	11.3	3.4	House pump.........	
14	....	...do.....	890	11.9	4.3	Sweep rig...........	Do.
15	....	...do.....	740	15.7	7.6	Chain pump.........	Fails.
16	....	...do.....	800	13.2	8.3	Pitcher pump.......	Do.
17	....	...do.....	685	13.6	9.6	Chain pump.........	Unfailing.
18	....	...do.....	795	13.0	8.5	Chain pump and house pump.	Do.

Dug wells ending in till in Harwinton—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
19		Slope	645	12.1	5.4	Windlass rig	Unfailing.
20		do	635	12.5	7.1	do	Do.
22		do	995	15.7	10.3	Chain pump	Do.
23		do	985	15.4	12.6		Do.[a]
24		do	990	18.7	6.5	Chain pump	Fails.
25		do	1,025	10.0	3.4	Chain pump and gasoline engine.	Unfailing.
26		Plateau	865	34.9	8.6	House pump	Do.
27		Slope	805	15.3	9.3	Windlass rig	Do.
28		do	855	12.5	5.2	Gravity system	Do.
29		do	830	12.0	8.0	([b])	
30		do	760	12.4	2.4	House pump	Do.
31		do	720	10.7	5.7	do	Fails.
32		do	820	15.7	11.9		
32a		Swale	810	9.0	2.4		
33		Slope	790	21.4	17.3	Chain pump	Unfailing.
34		Hilltop	910	16.1	9.3	do	Do.
36		do	1,050	23.0	5.3	Windlass rig	Fails.
37		Slope	995	14.7	10.3	Chain pump	Unfailing.
38		do	985		30	Deep-well pump	Do.
39		Hilltop	1,030	11.4	1.8	Chain pump	Do.
40		do	1,025	19.3	3.2	Windlass rig	Fails.
43	C. H. Wilson	Slope	860	9.4	2.9	Chain pump	Unfailing.
44	Newman Hungerford.	do	960	16.9	6.6	do	Do.
45		do	965	9.6	4.6	do	
46		do	935	17.1	12.0	House pump	Do.
47		do	935	11	5	do	Do.
48a	H. W. Acherson.	do	840	17.5	13.6	Chain pump	Do.[c]
49		do	825	16.4	10.4	([b])	Fails.
50		do	895	22.9	16.4	Chain pump	Unfailing.
51		Plain	870	9.8	6.7	do	
53		Slope	920	8.9	4.9	Sweep rig	Do.
54		do	835	13.2	7.0	Chain pump	Do.
55		do	830	13.1	8.6	Windlass rig	Rock bottom; fails.
56		do	830	13.1	7.7	Chain pump	Unfailing.
57		do	755	16.3	9.1	Windlass rig	Do.
58		do	825	22.2	8.1	Chain pump	Do.
59		do	840	11.6	7.0	do	Fails.
60		do	860	18.4	7.1	do	
61		do	1,030	13.2	3.3	Windlass rig	
62		do	1,065	31.7	20.5	do	Do.
63		do	1,035	15.4	10.1	do	Do.
64		do	1,025	15.7	5.1	([b])	Do.
66		do	885	12.5	9.2	Chain pump	Unfailing.
68		do	950	21.8	16.7	do	Fails.
69	M. C. Webster	Hilltop	945	23.7	10.4	do	Unfailing; for analysis see p. 148.
69a	do	do	945	19.4	11.2	do	Fails.[d]
70		Slope	915	11.7	7.6	do	Do.
71		do	920	26	24	Two-bucket rig	Do.
72		Hilltop	905	15.9	7.6	Windlass rig	Unfailing.
73		Slope	910	19.6	7.5	Gravity system	Do.[e]
75		do	895	25.8	20.1	Windlass rig	Fails.
76		do	865	12.5	3.8	Sweep rig	Unfailing; rock bottom.
77		do	755	15.1	9.0	do	Do.
78		do	710	14.3	8.5	Chain pump	Fails.
79		Plain	460	15.0	9.9	Windlass rig	
80		Slope	470	16.2	13.0	Two-bucket rig and house pump.	Unfailing.
82		do	470	17.7	12.4	Two-bucket rig	
83	James Elliott	do	780	9.3	3.7	House pump	Fails.
84		Plateau	925	14.1	8.7	Windlass rig	Do.
85		do	880	13.8	10.5	do	Do.
86		Slope	820	11.6	7.5	do	
87		do	780	14.0	6.3	Sweep rig	Unfailing.
88		Swale	800	13	6	Windlass rig	
89		Slope	460	16.0	5.2	Chain pump	
90		do	945		40	Deep-well pump	Rock bottom; unfailing.

[a] Dug into rock from fissures from which water issues.
[b] No rig.
[c] 200 feet west of well No. 48.
[d] At barn, 200 feet west of well No. 69.
[e] Flows a gallon in about 9 minutes.

Dug wells ending in till in Harwinton—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
91		Slope.	910	13.2	6.9	Pitcher pump	Fails.
92		do.	985	17.3	11.1	Chain pump	Unfailing.
93		Ridge	860	19.9	18.4	(a)	
94		Slope	820	16.5	12.5	Windlass and pulley rig.	Fails.
95		do.	798	15.4	9.1	(a)	Unfailing.
96		do.	765		22.5	Windlass rig	16 feet in rock; fails.
97		do.	690	12.6	7.4		Rock bottom; fails.
98		do.	605	17.3	11.4	Windlass rig	Unfailing.
99		do.	610	16.1	12.4	Chain pump	
101		do.	615	12.3	9.5	do.	Do.
102		do.	620	15.5	12.9	Windlass rig	Do.
103		do.	560	18.6	15.0	do.	
104		do.	500	19.2	12.8	Two-bucket rig	Fails.
106		do.	755	17.5	15.3	Windlass rig	Unfailing.
107		Slope	640	18.3	12.9	No rig	Fails; rock bottom.
108		do.	530	16.6	11.8	Windlass rig	Do.
109		do.	620	8.3	4.0	do.	Unfailing.
110		do.	750	21.0	16.5	do.	Fails.[b]
111		do.	855	14.9	8.9	Chain pump	Do.
112		Plateau	820	16.4	10.5	House pump	Unfailing.
113		do.	805	19.4	16.3	Windlass rig	
114		do.	985	14.8	11.1	Pitcher pump	Rock bottom; fails.
115		do.	975	17.8	9.7	Windlass rig	
116		Slope	970	31.0	22.5	do.	Unfailing.
117		do.	965	16.7	10.3	Chain pump	
118		do.	935	18.8	14.1	do	
119		do.	940	23.6	17.6	Windlass rig	Fails.
120		do.	960	15.6	11.6	Windlass rig and house pump.	Do.
121		do.	920	18.8	10.4	House pump	Do.
122		do.	860	20.5	18.4	Wheel and axle rig	Unfailing.
123		do.	860	18.3	17.2	Windlass rig	Rock bottom; fails.
124		do.	1,100	14.4	13.7	do.	Do.
126		Plateau	905	16.3	11.2	do.	Do.
127		do.	920	23.5	16.4	Sweep rig	Unfailing.

[a] No rig. [b] Maximum depth of water is 9 feet.

Dug wells ending in stratified drift in Harwinton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1		Slope	580	14.6	6.3	Chain pump	Unfailing.
21		do.	500	17.2	13.3	do.	Do.
65		do.	900	18.5	14.1	do.	Fails.
74		do.	510	24.4	21.6	Windlass	Dug into rock; fails.
100		do.	615	10.7	5.9	do.	
105		Plain	460	13.1	9.2	Chain pump	Unfailing.
128		do.	715	22.6	18.6	Windlass	Do.
129		do.	710	12.9	10.8	do.	Do.

Drilled well in Harwinton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*		
48	H. W. Ackerson.	Slope	860	102	15	9	Gneiss	Windmill; for assay see p. 148.

Springs in Harwinton.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*°F.*	*Gallons.*	
35	....	Slope..........	900	56	....	
41	Catlin Memorial Trough	Swale.........	940	54	....	Gravity system; for analysis see below.
42	Newman Hungerford..	Slope.........	870	50	¼	Unfailing; for assay see below.
52	H. W. Ackerson........	.....do.........	860	....	Large.	Windmill; for assay see below.
67	Orrin Woodin...........	.....do.........	940	48	30	Unfailing.
81	....	.....do.........	500	52	....	Water issues from a ledge.
125	....	.....do.........	1,060	....	2	Gravity system to house and horse trough.

QUALITY OF GROUND WATER.

The results of two analyses and three assays of samples of ground water collected in Harwinton are given below. The waters are of the calcium-carbonate type except Nos. 69 and 42, which are sodium-chloride and sodium-carbonate, respectively. All are low in mineral content, ranging from 53 to 301 parts per million of total dissolved solids; and all are soft, No. 42 containing the lowest amount of total hardness as calcium-carbonate and No. 69 the highest amount.

According to the analytical results, all the waters are good for domestic use; but high chloride content in No. 69, taken in connection with the high nitrate, indicates the possibility of pollution, probably from surface drainage. No. 69 is classed as only fair for boilers because of the considerable amount of scale-forming constituents it contains; the rest of the waters are rated as good for boiler use.

Chemical composition and classification of ground waters in Harwinton.

[Parts per million; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 146–148.]

	Analyses.[a]		Assays.[b]		
	41	69	42	48	52
Silica (SiO_2)	8.5	12	....	....	....
Iron (Fe)	.05	.05	Trace.	Trace.	Trace.
Calcium (Ca)	9.0	34	....	....	....
Magnesium (Mg)	2.4	9.6	....	....	....
Sodium and potassium (Na+K)[c]	2.8	57	14	13	Trace.
Carbonate radicle (CO_3)	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	20	105	24	76	46
Sulphate radicle (SO_4)	3.7	21	5	Trace.	Trace.
Chloride radicle (Cl)	6.0	92	6	19	4
Nitrate radicle (NO_3)	12	14	....	....	....
Total dissolved solids	53	301	c 53	c 110	c 61
Total hardness as $CaCO_3$	c 32	c 124	6	63	43
Scale-forming constituents[c]	39	130	20	80	60
Foaming constituents[c]	8	150	40	30	Trace.
Chemical character	Ca-CO_3	Na-Cl	Na-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion[d]	(?)	(?)	N	(?)	(?)
Quality for boiler use	Good.	Fair.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.
Date of collection (1915)	Aug. 3	Nov. 22	....	Aug. 6	Nov. 22

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Computed.
[d] Based on computed value; (?)=corrosion uncertain; N=noncorrosive.

NEW BRITAIN.

AREA, POPULATION, AND INDUSTRIES.

Of all the towns considered in this report, New Britain is the only one east of the range of trap ridges of the Connecticut lowland. The town is in the southern part of Hartford County and contains the city of New Britain, with which it is coterminous. Outside the built-up portion there is a considerable district served by rural delivery from the central post office, which also serves the city with regular carriers. The Highland division of the New York, New Haven & Hartford Railroad runs through New Britain, and there is a branch 2½ miles long that joins the main line of the Hartford division at Berlin. Trolley lines connect New Britain with Hartford, Berlin, Plainville, Southington, Meriden, and more distant points.

New Britain has an area of 13½ square miles, of which 20 per cent is wooded. The woodlands are restricted chiefly to the hills in the western and northern parts of the town.

New Britain was settled in 1687 as a parish of Farmington. In 1785 Berlin, which then included New Britain, was separated from Farmington, and in 1850 New Britain was taken from Berlin and separately incorporated. Subsequently a borough was formed, which in 1871 was reorganized as a city. In 1905 the city was made coterminous with the town.

In 1910 the population of New Britain was 43,916, of whom 18,015 were foreign born. In 1920 it was 59,316. The growth in population since 1850 has been rapid and uniform, owing to the vigor and stability of the manufacturing industries. In 1850 the railroad from Hartford to Bristol by way of New Britain was built, and in 1855 it was extended to Waterbury. In 1848 the railroad between Hartford and New Haven was opened, and in 1865 the branch to New Britain was finished. These railroads have provided the transportation facilities vital to New Britain's manufacturing industries. The introduction of a water supply in 1857 is said to have given a marked impetus to manufacturing, because it made possible the use of steam engines. It is to be expected that the population will continue to increase as in the past and that every few years it will be necessary to arrange for extensions of the water supply.

Population of New Britain, 1850–1920.[a]

Year.	Population.	Year.	Population.
1850	3,029	1890	19,007
1860	5,212	1900	28,202
1870	9,480	1910	43,916
1880	13,979	1920	59,316

[a] Figures up to 1870 from Connecticut Register and Manual, 1915, p. 654; figures from 1880 to 1920 from reports of the United States Census.

The principal manufactures of New Britain are hardware, cutlery, edge tools, hosiery, and foundry and machine-shop products. Hardware of various sorts forms over 50 per cent of the products, and the name "hardware city" is often applied to New Britain.

SURFACE FEATURES.

The topography of New Britain is somewhat intricate and reflects the structure, distribution, and character of the rocks. Two portions may be recognized—a very hilly and rugged western portion and a gently rolling eastern portion.

The rocks underlying New Britain are trap and red sandstone and shale, all of Triassic age. The deposition of the sands and clays that eventually hardened to form the sandstone and shale was interrupted on three occasions by the quiet volcanic eruption of lava, which spread out in broad sheets that hardened to form the trap rocks. Within the

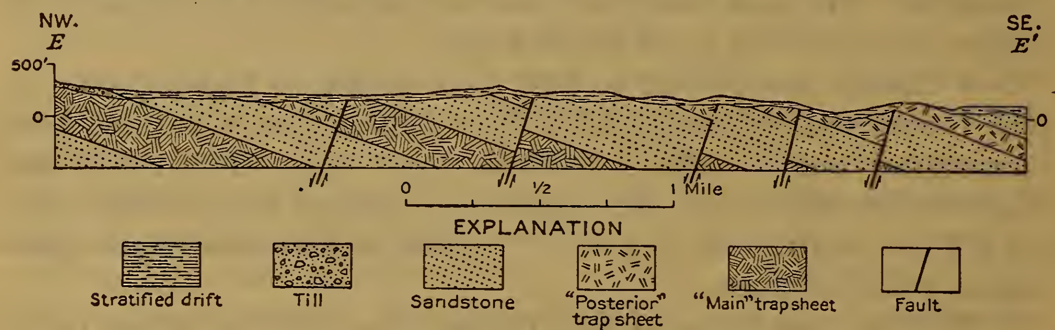

FIGURE 25.—Section across New Britain.

limits of New Britain are found parts of the second and third sheet. The second is called the "Main" sheet, as it is the thickest (400 to 500 feet) and has the greatest topographic effect. The upper sheet is thinner (100 to 150 feet) and is called the "Posterior" sheet, as it crops out on the back slope of the main ridge. Between these trap sheets there is about 1,200 feet of sandstone, and a similar series of beds separates the "Main" sheet from the underlying "Anterior" sheet, which is thus named because it crops out on the face or cliff side of the "Main" sheet. The "Anterior" sheet does not crop out in New Britain, but it undoubtedly extends under much or all of the town. After their consolidation these rocks were broken into great fault blocks, and the blocks were tilted to the east. The soft shales and sandstones have been eroded away and have left the harder trap sheets standing as high ridges. Block faulting has caused the repetition of the outcrops in some places and their elimination in others. Only by such a mechanism can the irregular distribution of trap knolls in the southern and eastern parts of New Britain be explained. Figure 25 is a structure section (indicated by the line *E–E′*

on the maps) showing the probable relation of the fault blocks in New Britain.

The kind of topography which weathering produces on rocks having such a structure is that shown by New Britain to-day, except for the superadded effects of glaciation, which has smoothed the surface, wearing off projections and filling in depressions. The hills of New Britain are partly buried in sands and gravels of glacio-fluviatile origin. Mr. T. A. Stanley's drilled well (No. 108, Pl. III) passed through about 100 feet of sand and gravel before reaching bedrock. These sediments form a great outwash plain which with minor interruptions extends eastward to Connecticut River. Most of the hills that rise above this plain have cores of trap, but in some the core is of sandstone, and others have no rock core at all. These are drumlins and are composed of till heaped up by the overburdened ice sheet.

The total relief of New Britain is moderate, only about 430 feet, and very few of the slopes are steep. The lowest point is where one of the branches of Mattabesset River crosses the Berlin town line, 55 feet above sea level, and the highest is on the slope of Bradley Mountain, 485 feet.

No large streams flow through New Britain. The northern half of the town is drained by the headwaters of South Branch, which joins Park River in Hartford and so reaches Connecticut River. The southeast corner is drained by tributaries of Mattabesset River, which joins the Connecticut at Middletown. A strip three-quarters of a mile by $1\frac{1}{2}$ miles along the western boundary is drained by the headwaters of Quinnipiac River, which flows through Cooks Gap to Plainville and then turns south. Formerly the direction of the flow through Cooks Gap was the reverse of the present and the stream carried the run-off of a large area of the western highland. This ancestor of the Pequabuck and Farmington followed the general course of the Mattabesset to Middletown. The diversion of this stream is discussed in the section on Plainville. (See p. 168.)

WATER-BEARING FORMATIONS.

Sandstone and trap.—The sandstones of the Connecticut Valley and the trap sheets associated with them have been broken and fissured very extensively by the jarring and crushing incident to the processes of block faulting and tilting. In addition, there are joints and fissures due to shrinkage either as the sediments dried out or as the igneous rocks cooled. A good deal of water which has fallen as rain soaks into these openings from the soil, and it may be recovered by means of drilled wells. Information was obtained concerning 11 drilled wells in New Britain. Their depth ranges from 36 to 500

feet and averages 237 feet. All these wells are believed to derive their water from fissures in the sandstone.

The well belonging to the Traut & Hine Manufacturing Co. (No. 55, Pl. III) is 270 feet deep. Sandstone was found at a depth of 15 or 20 feet, and farther down the drill went through a rather thin sheet of trap rock, presumably the "Posterior" sheet, below which water was obtained. There was enough hydrostatic head to make the water flow from the well. The probable conditions are shown in figure 26. The trap rock is presumably relatively free from joints at this point and acts as a restraining member. The water that percolates into the cracks in the sandstone west of the point marked *B* flows through the complicated network of fissures. Once it passes *B*, the edge of the trap sheet, the water is restricted, and hydrostatic head is developed under the influence of gravity. A well drilled at

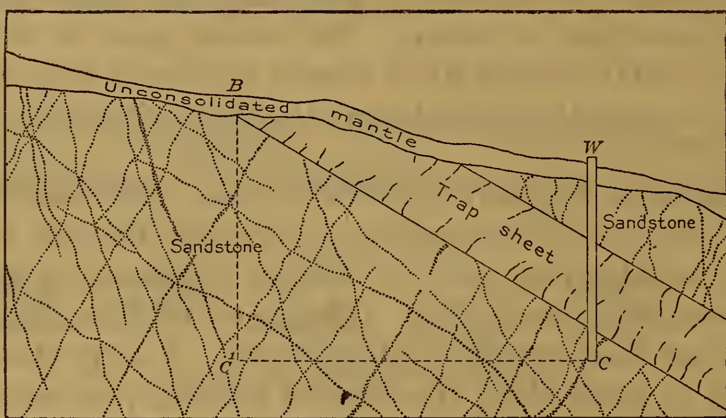

FIGURE 26.—Diagram showing probable relation of the flowing well of the Traut & Hine Manufacturing Co., New Britain, to the trap sheet.

W will reach fissures in the lower part of the trap sheet and in the underlying sandstone. The hydrostatic head of the water in these fissures will be equal to the head of a column of water of the height *BC'*, less a certain correction for the frictional resistance in the narrow channels. If the difference in elevation is great enough to overcome the frictional effect, the water will flow from the well. The Traut & Hine well yielded an abundance of water, but it was too highly mineralized for the company's particular uses and the well has been abandoned.

The Stanley Works (Inc.) has a drilled well (No. 48, Pl. II) whose situation is somewhat similar to that of the Traut & Hine well. It was drilled through 20 or 25 feet of soil and 50 feet of sandstone and entered but did not go through a "blue-gray" rock, presumably trap. The total depth is 250 feet. The water stands about 40 feet below the ground level, and a big supply is pumped. It is possible that had the well been sunk through the trap it might have struck

water under sufficient head to produce a flow, but this is improbable. In the first place, certain of the fissures would probably allow the head to be dissipated, and in the second place, as the trap rock is probably part of the "Main" sheet, 400 feet or more thick, the great depth would tend to close the channels of circulation.

Dug well No. 63 was blasted 32 feet into the trap of the crest of a low ridge formed by the "Posterior" sheet. The owner says that in the spring it is sometimes nearly full and that in summer it fails. The excess water in the spring is probably surface water. The failure in summer is due to the smallness of the fissures and the slight depth. These disadvantageous factors overcome the great abundance of the cracks cut by the well.

Till.—The western part of New Britain and the hills of the eastern portion above an elevation of 220 feet above sea level are mantled with till through which a few ledges crop out. The till consists of clay, sand, pebbles, and boulders intermingled in all proportions and with no sorting or washing into separate beds. It is the product of direct deposition by ice without the intervention of aqueous action. Wells dug in till yield water which seeps in slowly from the fine pores. The yield is in general not great, but as a rule it is obtained at moderate depths. Of the 55 wells dug in till that were measured in New Britain 3 were found to be dry. The depth to the water level in the remaining 52 wells ranged from 2.9 feet in well No. 22 (Pl. III) to 60 feet in well No. 29 and averaged 14.9 feet. Information as to reliability was obtained for 18 of these wells, of which 12 were said to be nonfailing.

Stratified drift.—The deposits of stratified drift that form the plains of New Britain are far more porous than the till of the hills. Wells in this material are apt to be more reliable, although 6 of the 16 whose reliability was ascertained are said to fail. In all 39 wells dug in stratified drift were measured in New Britain. Their depth to water ranged from 3 feet in wells Nos. 61 and 65 to 40.9 feet in well No. 102 and averaged 16.1 feet.

There are also a number of driven wells which draw from the stratified drift. The P. & F. Corbin Co. has a battery of five such wells which together will yield 50 gallons a minute. The wells are so closely spaced that they interfere with one another, for any one well alone will yield 25 gallons a minute. It is possible to procure a good deal of water in this way, even in the built-up portions of the city. In such locations, however, the sanitary character of the water is questionable.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in New Britain.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1		Slope	395	11	7	(a)	
2		Hilltop	390	24.7	14.8	2-bucket rig	Unfailing.
3		do	390	25.1	13.8	Windlass rig	
4		Plain	330	16.7	14.0	do	
6		Slope	320	12.8	12.0		Abandoned.
7		Hilltop	325	41.1		Windlass rig	Fails.
8		do	335	6.4	4.9	Deep-well pump	
9	M. A. Hunter	Slope	330	38.1	31.7	Windlass rig	For analysis see p. 157.
10		do	300	60	55		Fails.
12		Hilltop	320	35.3			Do.
13		Slope	310	48.3	40.8	Windlass rig	Do.
14		Hilltop	320	30.9	26.6	do	Unfailing.
15		Slope	440	33.6	32.5	do	Do.[b]
16		do	440	21.5			Fails.
17		do	240	16.2	13.6	Windlass rig	
18		Hilltop	370	41.1	18.4	do	Unfailing
19		Slope	325	10.1	8.0	Chain pump	
20		do	300	8.0	3.9		
21		do	310	23.4	17.1		Do.[c]
22		do	305	4.5	2.9		
23		do	280	11.3	10.3	(a)	New well.
24		do	310	27.2	23.0	Windlass rig	
26		Hilltop	320	12.3	11.4	Chain pump	Fails.
27		do	330	13.4	12.2	do	
28		Slope	330	20.2	17.4	do	
29		do	315		60	2-bucket rig	Temperature 49° F.; unfailing.
30		do	320	41.2	18.3	Windlass rig	Unfailing.
31		do	310	33.9	21.8	Wheel and axle rig	
32		Hilltop	325	21.6	15.9	Chain pump	Fails.
34		do	330	25.8	19.2	Windlass rig	Do.
35		do	330	19.3	12.9	Chain pump and windmill.	Unfailing.
36		do	330	27.3	16.0	Windlass rig	
37		do	305	16.0	11.3	Chain pump	
38		do	305	20.5	16.8	do	
39		do	290	41.2	19.5	2-bucket rig	
40		Slope	260	39.3	29.6	Gravity system	
41		do	240	19.8	16.9	Windlass rig	Do.
42		Valley	220	17.1	14.8	do	
43		Hilltop	265	39.6	31.0	2-bucket rig	
44		Plain	195	13.9	12.0	Windlass rig	
45		do	195	11.9	9.6	2-bucket rig	
46		do	190	16.0	11.7	Windlass rig	
47		Slope	205	20.3	19.6		
54	Landers, Frary & Clark.	Plain	170		30.7		(d).
54a	do	do	170		31.5		(d).
56		Hilltop	300	21.5	14.0	Chain pump	
57		do	300	24.7	15.6	do	Unfailing.
58		do	290	23.9	17.3	do	Do.
59		Slope	280	20.9	19.9	do	
65		do	195	6.2	3.0		
66	W. H. Ibelle	do	200	27.0	20.1	(a)	Abandoned.
66a	do	do	220	11	5	Gravity system	For assay see p. 157.[e]
68		do	180	11.5	6.5	do	Unfailing.
97		Slope	160	22.6	13.2	Windlass rig	
98		do	200	13.6	13.1	Sweep rig	

[a] No rig.
[b] Well reaches rock. There is a drill hole running down deeper.
[c] Never less than 5 feet of water.
[d] Wells 54 and 54a are dug on the site of a filled-in pond. They are dug to rock and get their water just on top of it.
[e] Supplied six families and a dairy.

Dug wells ending in stratified drift in New Britain.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
5	....	Slope....	240	14.0	12.1	Chain pump........	Fails.
11	....	...do....	290	31.2	28.5	Windlass............	
60	....	Ridge...	190	29.9	26.4	....	Fails; 12 feet in trap.
61	....	Swale...	170	7.0	3.0	....	Unfailing; tiled.
62	....	Ridge...	185	6.9	3.1	....	Tiled.
63	....	...do....	185	32.2	22.4	Chain pump........	In trap; fails.
64	....	Slope...	160	14.5	12.5	....	Tiled; unfailing.
69	....	...do....	120	18.6	17.1	Windlass............	Reaches rock; unfailing.
70	....	Plain...	130	22.6	21.4	Chain pump........	Abandoned.
72	....	Terrace.	120	25.0	23.7	.....do.............	Temperature 58½° F.; unfailing.[a]
74	....	Plain...	120	25.1	24.3	Two-bucket rig......	
75	....	...do....	100	15.0	10.5	.....do.............	
76	....	...do....	120	34.0	33.6	....	Abandoned
78	....	Valley..	100	16.6	11.7	Windlass............	
79	....	Plain...	160	21.1	16.1	Two-bucket rig.....	
80	....	...do....	155	18.4	16.0	.....do.............	
81	....	...do....	165	22.9	19.8	Windlass............	
82	....	Slope...	345	6.6	4.1	.....do.............	
83	....	...do....	320	26.0	25.7	.....do.............	Fails.
84	....	...do....	310	15.1	14.4	Chain pump........	Abandoned.
85	....	...do....	225	20.0	15.6	.....do.............	Unfailing.
86	....	Valley..	170	18.2	18.0	....	Abandoned; fails.[b]
87	....	Slope...	180	19.6	15.2	Chain pump........	([b])
88	....	...do....	220	15.3	11.9	....	Fails.
89	....	...do....	150	27.1	24.4	Chain pump........	
91	....	...do....	160	25.5	21.2	.....do.............	Unfailing.
92	....	...do....	160	23.1	17.0	.....do.............	Do.
93	....	Plain...	200	20.1	13.8	Two-bucket rig.....	Do.
96	Corbin Cabinet Lock Co.	...do....	230	....	30.0	....	([c]).
99	....	Slope...	140	15.5	11.0	Windlass............	Fails.
100	....	...do....	120	21.1	20.5	....	Abandoned.
101	....	...do....	90	13.2	12.9	....	([b]).
102	....	...do....	170	41.8	40.9	....	Abandoned.
103	....	Plain...	130	20.1	16.9	Windlass............	
104	T. A. Stanley....	Slope...	80	26.0	11.0	Electric pump......	Unfailing.
105	....	Plain...	125	14.1	12.8	Windlass............	Do.
106	....	...do....	125	15.4	11.5	.....do.............	Do.
107	....	...do....	120	15.9	13.6	.....do.............	Abandoned.
109	....	...do....	100	21.3	20.9	.....do.............	Fails.

[a]Was once pumped for 2½ hours in fighting a fire and did not fail.
[b]Prior to the digging of a sewer in the street these wells never failed. Presumably the loose soil in the trench allows the ground water to percolate away.
[c] Elliptical shape, 12 by 15 feet. Used chiefly for fire purposes. Has a capacity of 75 gallons a minute.

Driven wells in New Britain.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Diameter.	Yield per minute.	Remarks.
			Feet.	*Feet.*	*Inches.*	*Gallons.*	
49	Corbin Screw Corp..	Plain....	160	30	3	80	
49a	.....do...............	...do....	160	30	2	50	
77	....	...do....	120	36	....	....	Unfailing.
90	....	...do....	255	35	....	....	
95	R. & F. Corbin......	...do....	170	24–30	....	([a])	

[a]A battery of 5 wells. Together they yield 50 gallons a minute, though any one well will yield 25 gallons a minute if the others are shut off.

Drilled wells in New Britain.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
33	....	Hilltop..	320	36	....	6	....	....	
48	Stanley Works (Inc.).	Slope....	200	250	20 or 25	8	150	(a).........	
50	Russell & Erwin	Plain...	190	328	80 or 90	8	90	Sandstone.	
51	.....do.........	...do.....	185	500	80 or 90	8	35	.....do.....	
52	City Hall.......	...do....	180	152	12	....	Large.	.....do....	(b).
53	Landers, Frary & Clark.	...do....	170	400	40	....	Good.	.....do.c...	For analysis see p. 157.
55	Traut & Hine Manufacturing Co.	...do....	165	270	15 or 20	....	...do...	Trap rock.d	
67	A. W. Stanley..	Hilltop..	340	232	18	....	5	Shale......	Pumped by windmill.
94	Young Mens' Christian Association.	Plain....	180	200	Slight.	....	38	Sandstone.	
109	Theo. A. Stanley.	...do....	125	134	100	....	6	.....do....	Windmill, abandoned.
110	....	...do....	75	99.5	21	....	5	.....do....	

a Said to have gone through 50 feet of red sandstone and then through "blue gray" rock, which is probably trap.
b Water enters the well at a depth of 150 feet.
c Most of the water enters the well at 300 feet, and a little more at 400 feet.
d See text (p. 152).

Springs in New Britain.

No. on Pl. III.	Topographic position.	Elevation above sea level.	Temperature.	Remarks.
		Feet.	°*F.*	
25	By a marsh ...	270	68	
71	Foot of slope..	115	58	Spring boxed in.
73	.....do.........	115	....	Unfailing; 3 feet above brook level, water drawn by a pump in the house.

QUALITY OF GROUND WATER.

In the following table are given the results of an analysis and an assay of ground-water samples collected in New Britain, together with one analysis furnished by a manufacturer in the city. No. 9 is calcium-carbonate in chemical character, and Nos. 53 and 66a are calcium-sulphate and sodium-chloride, respectively. No. 53 is low and Nos. 9 and 66a are moderate in mineral content. Although all the waters are soft, No. 66a is especially low in hardening ingredients. In the consideration of the waters for domestic use the amount of nitrate in No. 9 is noticeably high. It may be derived from vegetable matter and not from animal pollution, but its presence warrants a careful sanitary inspection of the well. Difficulty may be experienced with the iron in No. 53. It is high enough to stain porcelain and to be objectionable in certain types of manufacturing. On account of its high content of scale-forming constituents No. 9 is classed as fair for

boilers; the other two waters are good because they contain but small amounts of scaling and foaming ingredients. The three waters may or may not corrode boilers, their action depending upon working conditions.

Chemical composition and classification of ground waters in New Britain.

[Parts per million. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 154–156.]

	Analyses.[a]		Assay.[b]
	9	53	66a
Silica (SiO_2)	24	2.0	
Iron (Fe)	.05	[c] 2.3	0.20
Calcium (Ca)	36	17	
Magnesium (Mg)	12	1.7	
Sodium and potassium (Na+K)[d]	9.6	[e] 2.9	51
Carbonate radicle (CO_3)	.0	[f] 11	0
Bicarbonate radicle (HCO_3)	90		19
Sulphate radicle (SO_4)	20	30	Trace.
Chloride radicle (Cl)	12	4.5	89
Nitrate radicle (NO_3)	60		
Total dissolved solids	212	[g] 71	[d] 180
Total hardness as $CaCO_3$[d]	139	49	[e] 40
Scale-forming constituents[d]	150	55	55
Foaming constituents[d]	26	8	14.0
Chemical character	Ca-CO_3	Ca-SO_4	Na-Cl
Probability of corrosion[h]	(?)	(?)	(?)
Quality for boilers	Fair.	Good.	Good.
Quality for domestic use	Good.	Fair.	Good.
Date of collection	Nov. 16, 1915	Jan. 6, 1911	Nov. 16, 1915
Chemist	(i)	(j)	(i)

a For methods used in analyses and accuracy of results, see pp. 59–61.
b Approximations; for methods used and reliability of results, see pp. 59–61.
c Oxides of iron and aluminum ($Fe_2O_3+Al_2O_3$).
d Computed.
e Determined.
f Carbonate and bicarbonate expressed as carbonate.
g By summation.
h Based on computed value; (?)=corrosion uncertain.
i S. C. Dinsmore.
j Analysis furnished by Travelers' Indemnity Co.; recomputed from hypothetical combinations to ionic form.

PUBLIC WATER SUPPLIES.

New Britain has been supplied with running water since 1857 by the board of water commissioners.[55] In that year a dam was built at Shuttle Meadow, on the Southington-New Britain boundary, and in the fall about 100 customers were served. In the following year the mains were extended to cover most of the borough. The reservoir covered 175 acres, had a capacity of 700,000,000 gallons, and gave a head of about 200 feet. In 1883 a canal, called the Panther Swamp "canal," was dug to increase the area tributary to the reservoir, and in 1886 the storage capacity was augmented by the addition of a 12-inch flashboard to the dam. This was not a sufficient increase, and in 1892 a new dam 10 feet higher was built and a second canal, the West canal, was dug to increase the tributary area. In

55 Information taken from annual reports of the board of water commissioners of the city of New Britain from 1875 to 1914.

1898 a small diversion dam was built on Roaring Brook west of Southington, and the water was piped across the valley by gravity to Shuttle Meadow, where it was stored. It was again found necessary to augment the capacity of the reservoir, so a 12-inch flashboard was added to the new dam in 1901, making a capacity of 1,400,000,000 gallons. The next improvement was the addition of a storage reservoir on Wolcott Mountain above the Roaring Brook diversion dam. This has a capacity of 142,000,000 gallons, floods 49 acres, and has a tributary drainage area of 2½ square miles.

By 1905 the available supply again seemed inadequate for the demands of the increasing population. In 1905 a dam was started on the so-called main brook above Whigville, in the town of Burlington. When completed in 1913 this reservoir had a capacity of 60,000,000 gallons. The water is carried by a pipe line 10½ miles long to its junction with the city mains. Part of it is run into a small high-service reservoir west of the city, and the excess is discharged into Shuttle Meadow reservoir. The total capacity of the system for a year of average rainfall is estimated at nearly 9,000,000 gallons a day. In 1915 surveys were being made on the headwaters of Burlington Brook, in Burlington, for a reservoir site and a pipe line to carry the water to the Whigville main and so to the city.

The system comprises about 85½ miles of main pipe, 4 to 24 inches in diameter, and supplies 636 hydrants and 4,815 service connections. As 4,824 meters are reported in use, allowing for the use of more than one meter on some taps, the supply is virtually all metered.[56]

The following table cites analyses of the water given in the reports of the board of water commissioners for the years ending March 31, 1909, 1911, 1913, and 1914. The analyses given are averages of monthly analyses made by Davenport & Keeler, consulting chemists in New Britain. The analysts state that no wide divergence from the average was noted.

Averages of monthly analyses of New Britain water supply.

[Parts per million.]

	1909	1911	1913	1914
Total solids	41	54	41	48
Volatile solids	21	22	18	20
Free ammonia	.02	.07	.03	.08
Albuminoid ammonia	.33	None.	None.	None.
Nitrogen as nitrates	None.	.04	.03	.38
Oxygen consumed	3.2	3.3	2.2	2.5
Chloride radicle	2.9	2.7	2.3	2.2

[56] Board of Water Commissioners of New Britain Fifty-seventh Ann. Rept., for the year ending Mar. 31, 1914.

NEW HARTFORD.

AREA, POPULATION, AND INDUSTRIES.

New Hartford is near the middle of the eastern boundary of Litchfield County and includes the junction of the East and West branches of Farmington River. The principal settlement is New Hartford village, near the northeast corner. Pine Meadow, the second settlement, lies southeast of New Hartford and is almost continuous with it. Nepaug, Bakersville, and Maple Hollow are small settlements in the upper valley of Nepaug River, and Town Hill, 2 miles south-southwest of the village, is a fourth. There are post offices at New Hartford and Pine Meadow, but the other sections are served by rural delivery from Winsted, Collinsville, Unionville Torrington, and New Hartford. The New Hartford branch of the Northampton division of the New York, New Haven & Hartford Railroad has its terminus at New Hartford and also has a station at Pine Meadow which is used jointly with the Central New England Railway. The latter runs north and south through the town and at New Hartford has a separate station. Stage lines connect New Hartford with settlements in Barkhamsted and Hartland.

New Hartford has an area of 37½ square miles, of which about 70 per cent is wooded. There are 109 miles of dirt roads worked by the town and 6 miles of bituminous-macadam road belonging to the State trunk line between Hartford and Winsted. The Hartford board of water commissioners has built some excellent macadam roads to replace those to be flooded by their new reservoir. Most of New Hartford is rugged, so that many of the grades are severe, and in parts of the upper valley of Nepaug River there is a good deal of sand. There are about 6 miles of roads that have been legally discontinued.

New Hartford was incorporated in 1738 and has had no change of territory or organization since. Previous to its incorporation this region was known as the Green Woods on account of the very fine forests. It has always been of some importance, as it is on one of the few easy lines of communication between central Connecticut and the northwestern part of the State, southwestern Massachusetts, and central New York. Manufacturing was begun early because of the excellent water power and the convenient routes of transportation. Prior to the manufacturing development Town Hill was the principal settlement, but New Hartford has far outstripped it. Manufacturing increased fairly steadily till after 1900, when one of the bigger companies moved its equipment away. The table below shows the changes in population since the incorporation of the town. The changes after 1800 for the most part reflect the degree to which manufacturing flourished.

Population of New Hartford, 1756–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1756	260	1820	1,685	1880	3,302
1774	1,001	1830	1,766	1890	3,160
1782	1,296	1840	1,703	1900	3,424
1790	....	1850	2,643	1910	2,144
1800	1,753	1860	2,758		
1810	1,507	1870	3,078		

a Connecticut Register and Manual, 1915, p. 654.

The principal industries are agriculture, including general crops and tobacco, and the manufacture of cotton goods, silks, brushes, and planes and rules.

SURFACE FEATURES.

New Hartford has a total relief of 835 feet. The lowest point is where Farmington River crosses the boundary, at 325 feet above sea level, and the highest elevation is about 1,160 feet at a number of points—two in the northwest corner, two in the southwest corner, and three south of New Hartford village. These are flat-topped hills and are believed to be remnants of one of the wave-cut terraces that formerly extended across Connecticut. (See Harwinton report, p. 143.) During the long time since the carving of the flat terrace floor it has been cut deeply by erosion, so that only a few small fragments remain.

In the report on Canton (see p. 104) there is a brief discussion of the gorge at Satans Kingdom, a mile south of Pine Meadow. Prior to the glacial epoch Farmington River followed a channel half a mile east of the present one. In late glacial time the eastern channel was blocked by a dam of stratified drift and the river was diverted into its new course, which it has cut to a deep gorge. When the dam was first built and before the gorge was cut there was a lake that extended northward and covered the present plain around Pine Meadow. A somewhat similar lake was made in part of Nepaug River valley and adjacent parts of the towns of Burlington and Canton.

Most of New Hartford is drained by Farmington River and its tributaries. The largest of these, Nepaug River, has been studied by the engineers of the board of water commissioners of the city of Hartford.[57] The greatest flow in the year 1913 occurred on October 26 and 27, after heavy rains (about 6 inches in 48 hours) when 1,400 second-feet was recorded. The area of the tributary drainage basin is 26.8 square miles, so that the discharge is equivalent to a run-off of 52 second-feet per square mile. The minimum flow for the same year occurred in August and was only 3⅓ second-feet, equivalent to 0.124 second-foot per square mile.

[57] Board of Water Commissioners of Hartford Sixtieth Ann. Rept., p. 45, 1915.

About 2 square miles in the southwest corner of the town is drained by headwaters of Leadmine Brook, which flows through Harwinton to Naugatuck River. Along the north boundary there are several small brooks which flow into Morgan River, in Barkhamsted. Several small brooks in the neighborhood of New Hartford empty directly into the Farmington. On August 23, 1915, after a rather rainy period, a float measurement was made on one of these, South Mountain Brook, a little west of the reservoir of the New Hartford Water Co., and gave a result of about 2 second-feet.

WATER-BEARING FORMATIONS.

Schist and gneiss.—Underlying New Hartford are three varieties of bedrock—the Hoosac schist, the Waterbury gneiss, and the Becket granite gneiss.[58]

The Hoosac schist is a typical light to dark gray mica schist. The mica is in the form of flakes which are roughly parallel and give the rock a pronounced cleavage characteristic of schists. Besides mica, the rock contains much granular quartz and a little garnet, feldspar, and staurolite. The schist underlies the area southeast of a northeast-southwest diagonal through the town, except about a square mile at the southwest which is underlain by Waterbury gneiss. This rock is believed by Gregory [59] to be a modification of the Hoosac schist made by the injection of granitic and quartzose veins in quantities sufficient to alter the character of the rock completely. Such injected sheets and dikelets are found in greater or less amounts almost everywhere in the Hoosac schist, but in the Waterbury gneiss they predominate over the schistose material. The Becket granite gneiss, which underlies the northwestern part of the town, is composed of alternating light and dark bands. The light bands consist chiefly of quartz and feldspar; the dark bands of black mica. White mica and garnet are found in subordinate amounts.

These bedrocks are of similar character and value as regards their water-bearing capacity. All are cut by a complicated network of fractures and joints, from which water that has percolated down from the soil above may be recovered by means of drilled wells. The fractures are numerous near the surface, but in depth they are fewer and narrower on account of compression by the weight of overlying rock. No water has yet been obtained from the bedrocks in New Hartford, but drilling operations should prove worth while where domestic and farm needs are not satisfied by springs and wells.

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[58] Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 7, 1907.

[59] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, p. 100, 1906.

Till.—There is a mantle of till over the bedrock of the town except where the rocks crop out and in the areas of stratified drift in the lowlands. The till is an unstratified or poorly stratified mass of boulders, pebbles, sand, and silt partly cemented together by very fine rock flour and clay. The pores between the grains are very small, but there is a considerable circulation of ground water through them and wells dug in till yield good supplies of water. The average depth to water in the 65 wells of this class that were measured in New Hartford was 10.2 feet, and the range was from 1.2 feet in well No. 23 (see Pl. III) to 28 feet in well No. 55. The reliability of 43 was ascertained; 11 were said to fail and 32 to be nonfailing.

Stratified drift.—The stratified-drift areas of New Hartford include the lake deposits of the Nepaug Valley and those above Satans Kingdom, the flood plain of Farmington River and the upper reaches of Nepaug River, and the small esker deposits. The eskers are of no importance as sources of water supply, as they are small and their topographic form is such as to allow water to escape readily. Two eskers are shown on the geologic map (Pl. II)—one $1\frac{1}{2}$ miles south of the village and another a mile west of it.

The flood plain and lake deposits of stratified drift are excellent bearers of ground water, for they are very porous and allow great freedom of circulation. Those of the lake deposits that were formed more or less as deltas are likely to have steep borders from which the water drains quickly, but the more flat-lying deposits are fairly reliable sources. Seventeen wells dug in this general class of material were measured in New Hartford. The depth to water was found to average 13 feet and to range from 4.8 feet in well No. 48 (see Pl. III) to 26.9 feet in well No. 58. Ten of these wells were said never to fail and five were said to fail; the reliability of the two remaining wells was not ascertained.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in New Hartford.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
2		Plateau	1,080	15.9	2.3	Chain pump	Unfailing.
3		do	1,030	19.5	6.5		
4		Valley	670	10.3	2.2	Gravity system	Do.[a]
6		Slope	670	12.5	9.2	Chain pump	
7		do	850	12.6	7.0	do	Do.
8	C. H. Rood	do	820	15.6	11.6	do	Do.
9		do	965	31.3	7.2	do	Do.
10		do	770	19.6	4.5	Deep-well pump	
11		do	710	29.0	13.1		Fails.
13		do	660	22.1	15.1	Windlass rig	Do.
14		do	610	11.9	7.3	Chain pump	Unfailing.
16		Hilltop	1,025	22.1	17.9	do	Fails.
17		do	1,055	15.7	5.6	do	Do.
18		do	820	20.3	8.7	([b])	Do.
20		do	1,175	25.6	17.8	Chain pump	Fails.
21		do	1,160	29.9	15.0	House pump	Unfailing.
22		Slope	990	16.5	4.9	Chain pump	

[a] 6 feet in diameter. Temperature 59° F.

[b] No rig.

Dug wells ending in till in New Hartford—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
23		Slope	970	22.4	1.2	Chain pump	Unfailing.
23a		do	970	22.5	6.8	do	Fails.[a]
25		do	640	31.1	27.8	do	Do.
26		Plateau	1,000	23.1	7.3		Rock bottom; fails.
27	Ellsworth	do	990	31.2	9.2	Chain pump	
28		do	990	32.9	2.1	do	Unfailing.
29		Slope	860	25.1	16.9	do	Do.
30		do	630	10.4	6.9	Windlass rig	
31		do	535	13.5	5.1	do	
32		do	565		15	Deep-well pump	Do.
34	Koch Bros	do	880	10.2	3.0	Gravity system	Do.
35		do	920	23.9	7.4	Windlass rig	
36		do	600	9.0	3.5	House pump	Do.
38		Plateau	1,040	24.0	7.7	do	
39	Mrs. A. E. Dietz	Slope	880	27.6	17.3	Chain pump	Fails; analysis p. 164.
41		Plateau	980	13.3	4.8	do	
42	E. W. Kellogg	do	980	22.8	4.4	Windlass rig and air-pressure system.	Analysis on p. 164.
43		Slope	900	15	10		
44		do	960	16.3	9.8	Windlass rig	
45		do	700	26.2	22.2		
47		do	770	13.0	1.5	Windlass rig	
50		Hilltop	670	13.9	7.9	Two-bucket rig	
51		do	700	15.3	8.8	Deep-well pump	Rock bottom; fails.
53		Plain	370	7.0	2.7	Chain pump	Unfailing.
54		do	400	10.5	9.3	Windlass rig	Do.
55	Richards	do	360	29.7	28.0	do	Do.
56		Slope	590	29.1	14.8	do	Do.
62		do	810	16.1	15.1	Chain pump	Do.
63		do	890	24.1	18.6	do	Do.
64		do	865	34.9	19.0	Windlass rig	
65		Plain	685	17.5	11.6	Pitcher pump	Do.
66		Slope	720	16.9	7.0	Wheel and axle rig	Do.
67		do	850	30.9	8.0	Chain pump	
68		do	830	26.6	16.7		Do.
69		do	720	16.4	10.6	Two-bucket rig	Do.
71		Plain	560	16.9	6.1	Windlass rig	Fails.
72		Slope	620	17.4	8.0	do	Unfailing.
73		do	710	21.5	7.0	Chain pump	
74		do	730	29.0	22.5	Two-bucket rig	Do.
75		do	915	15.5	9.2	(b)	
76		do	840	22.8	9.7	Chain pump	Do.
77		Plain	500	10.6	7.2	Deep-well pump	Do.
80		Slope	865	10.9	7.1	Windlass rig	Do.
81		Plain	815	16.8	14.6	House pump	
87		Slope	665	18.4	16.2	Deep-well rig	Do.[c]
88		Plain	800	9.8	8.6	(b)	Do.
89		do	820	18.9	13.5	Chain pump	
92		Slope	480	13.4	10.1	Windlass rig	Do.

[a] 100 feet south of well No. 23. [b] No rig. [c] Never over 5 feet of water.

Dug wells ending in stratified drift in New Hartford.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
15	W. R. Goldbeck	Plain	570	11.0	9.0	Pitcher pump	Unfailing; assay, p. 164.
24		do	660	18.8	17.8	Chain pump	Fails.
46		Slope	600	22.9	16.6	Two-bucket rig	Unfailing.
48		do	700	10.4	4.8	Chain pump	Do.
49		do	580	16.0	13.6	Sweep rig	Fails.
58		Plain	360	29.4	26.9	Windlass	Do.
60		do	350	15.9	9.4	do	
70		do	555	25.0	21.6	do	Unfailing.
78		do	540	18.9	16.5	do	Fails.
79		do	535	9.7	6.3	(a)	Do.
83		Slope	550	19.0	15.4	House pump	Unfailing.
84		do	540	14.1	9.0	Windlass	Fails.
85		do	555	15.3	11.5	Chain pump	Unfailing.
90		Plain	795	12.4	7.9	do	Do.
91		do	790	18.3	12.5	do	Do.
93		Slope	500	24.0	17.1	Windlass	
94		do	530	9.8	6.3	Chain pump	Do.

[a] No rig.

Springs in New Hartford.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*° F.*	*Gallons.*	
1	....	Slope..........	1,020	55		
5	....	.....do........	740	52	....	Ram delivers ⅓ gallon a minute at the house.
12	....	.....do........	600	56	....	Gravity system to two houses.
19	....	.....do........	950	54	....	Ram.
33	Koch Bros..........	.....do........	750	49	....	Unfailing; for analysis see p. 164.
37	....	Plateau........	1,075	55	....	Gravity system; fails.
40	....	Slope..........	910	47	....	Gravity system; unfailing.
52	....	.....do........	550	65		
57	....	.....do........	400	55		
59	Geo. Hotchkiss..........	.....do........	535	49	1½	Unfailing; water issues from fissures in a ledge.
61	Satans Kingdom Bottling Works.	.....do........	380	45	200 to 300	Ram.
82	....	Plain..........	550	57	....	Water brought out by an outcrop of bedrock.
86	....	Slope..........	535	49	....	

QUALITY OF GROUND WATER.

The results of three analyses and one assay of samples of ground water collected in New Hartford are given below. The waters are all low in mineral content, very soft, low in scale-forming constituents, and of the calcium-carbonate type except No. 15, which is a sodium-chloride water. All are suitable for domestic or boiler use, although the comparatively high chloride in No. 15 may possibly indicate pollution.

Chemical composition and classification of ground waters in New Hartford.

[Parts per million; S. C. Dinsmore, analyst; collected Nov. 30, 1915. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 163–164.]

	Analyses.[a]			Assay.[b]
	33	39	42	15
Silica (SiO_2)..........	19	6.5	14	....
Iron (Fe)..........	Trace.	.60	.25	Trace.
Calcium (Ca)..........	11	6.5	14	....
Magnesium (Mg)..........	4.1	.6	1.5	....
Sodium and potassium (Na+K)[c]..........	4.5	2.9	2.4	57
Carbonate radicle (CO_3)..........	.0	.0	.0	0
Bicarbonate radicle (HCO_3)..........	32	22	46	71
Sulphate radicle (SO_4)..........	3.2	2.9	2.8	15
Chloride radicle (Cl)..........	6.0	3.0	4.0	81
Nitrate radicle (NO_3)..........	20	Trace.	Trace.	....
Total dissolved solids..........	86	35	66	[c] 230
Total hardness as $CaCO_3$ [c]..........	44	19	41	[d] 74
Scale-forming constituents [c]..........	58	27	58	90
Foaming constituents [c]..........	12	8	6	150
Chemical character..........	Ca-CO_3	Ca-CO_3	Ca-CO_3	Na-Cl
Probability of corrosion [e]..........	(?)	(?)	(?)	(?)
Quality for boiler use..........	Good.	Good.	Good.	Good.
Quality for domestic use..........	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Computed.
[d] Determined.
[e] Based on computed value; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

The village of New Hartford has two water companies that serve overlapping territories. The older company is the outgrowth of a commercial system and is not very extensive. The younger and larger company was organized to give a service adequate to the demands of the manufacturers for fire protection.

The service now maintained by the Village Water Co. of New Hartford was commenced sometime prior to September, 1825. At first water was carried from a brook through an open ditch to a collecting basin and thence by log pipes to a tub in the village, where the people came and dipped it. Later lines of log pipe were run from the collecting basin to several of the houses. In 1861 the log pipes were for the most part replaced by iron pipes. The next improvement was made in 1891, when a 6-inch main was laid from the "dry well," as the collecting basin was called, with small distributing pipes to the houses. At this time the first formal organization, a voluntary association, was made. In 1905 the association was reorganized as a joint stock company, and the present dam and reservoir were built on a stream west of the village. The dam has a maximum height of 14 feet, has a 12-inch core wall, and gives a storage capacity of 1,250,000 gallons. Water is delivered by gravity under a pressure of about 80 pounds to the square inch through about a mile of main to 38 service connections. There is a second reservoir for emergencies. According to Mr. C. E. Jones, the manager, the supply is used entirely for domestic purposes.

The New Hartford Water Co. was incorporated in 1891 for the purpose of providing fire protection for the mills in New Hartford and Pine Meadow. A stone dam 17½ feet high was constructed on South Mountain Brook at an elevation of 715 feet above sea level, making a reservoir with a capacity of 3,500,000 gallons. Operations were begun in 1894. The water is distributed by gravity through 6½ miles of mains and is delivered to 63 fire hydrants and 190 service connections. The pressure ranges from 120 pounds to the square inch in the higher parts of the village to 155 pounds in Pine Meadow.

It is probable that these supplies will be sufficient for the demands of New Hartford for many years, and the streams are probably capable of filling reservoirs of much greater capacity.

In the southeast corner of New Hartford and the adjacent parts of Burlington and Canton the board of water commissioners of Hartford is constructing a reservoir. The reservoir will store the waters of Nepaug River and Phelps and Clear brooks will flood 851 acres, and will have a capacity of 8,500,000,000 gallons. The dam on Nepaug River will be of cyclopean concrete masonry, have a maximum height of 140 feet, and be 550 feet long. It was necessary in places to

remove 50 feet of loose mantle rock from the valley bottom in order to get a solid-rock foundation. The dam on Phelps Brook is of the earth-banked core-wall type and will be 1,200 feet long and have a maximum height of 140 feet. A short, low dike will be constructed across the sag in the rim of the reservoir between the two dams. The supply line to the city is for the most part 42-inch cast-iron pipe, but part of it is a tunnel half a mile long through Talcott Mountain. In order to compensate the owners of power rights in Collinsville, Unionville, and Tariffville for the loss of the summer flow of Nepaug River and Phelps Brook a compensating reservoir is being built on East Branch of Farmington River. The dam is to be about a mile east of New Hartford village and will be of the earth-banked core-wall type, with a maximum height of 120 feet and a length of 800 feet. The 3,500,000,000 gallons of water which this reservoir will store will be held at the disposal of the power users for release as they wish.

PLAINVILLE.

AREA, POPULATION, AND INDUSTRIES.

Plainville is a small town halfway between the Massachusetts boundary and Long Island Sound, in the Farmington-Quinnipiac Valley. The village of Plainville is the only settlement and is built up almost continuously with Forestville, which is just across the Bristol town line on the west. There is a post office with regular carrier delivery in the village and rural delivery to the outlying districts. The Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad runs north and south through the town, and the Highland division east and west. Their joint station is at the village. Trolley lines connect Plainville with Bristol, Terryville, Compounce Pond, Southington, Meriden, New Britain, and more distant points.

The area of Plainville is 9½ square miles, most of which is cleared. The woodlands in the east with small patches in the northeast corner aggregate 3 square miles. Plainville is on two State trunk-line highways—one between Southington and Farmington and one between New Britain and Bristol. These have a total length of 7 miles in Plainville, in addition to which there are 13 miles of dirt roads and streets. Although the soil is sandy in most places in the town the roads are well kept up and are uniformly good.

Plainville, originally known as Great Plains, was separated from Farmington in 1869 and incorporated as a town. The population in 1910 was 2,882, and of these about 2,500 lived in the village. The growth in population has been fairly rapid and steady and probably reflects the growth of the manufacturing establishments. Two fac-

tors will influence the future growth, but it is impossible to say which will predominate. The nearness of larger manufacturing centers, such as Bristol and New Britain, may tend to draw business away from Plainville and so hinder its growth. On the other hand, the level ground around Plainville gives many excellent factory sites which with the advantageous position at the junction of two railroads may induce manufacturers to locate here.

Population of Plainville, 1870–1910.[a]

Year.	Population.	Year.	Population.
1870	1,433	1900	2,189
1880	1,930	1910	2,882
1890	1,993		

[a] Connecticut Register and Manual, 1915, p. 655.

Most of the population of Plainville is dependent on manufacturing of various sorts, but there is a little general farming and truck raising. The principal manufactured products are knit underwear, electric sundries, small hardware and tools, and brass goods.

SURFACE FEATURES.

Plainville has a total relative relief of 530 feet, the range of elevation being from 155 to 685 feet above sea level. There are two low points, one where Pequabuck River crosses into Farmington and the other where Quinnipiac River crosses the Southington line. The highest point is on Bradley Mountain, in the southeast corner.

Most of Plainville is a very level sand plain formed by the heavily burdened streams of melt water that issued from the ice sheet about the end of the glacial epoch. Upon leaving the glacier the velocity of the water was much reduced and it was forced to drop its load of detritus, and in this way deposits of well-washed sand and gravel were laid down in front of the glacier, forming a glacial outwash plain. This fill is very deep, as is shown by the well of the Trumbull Electric Manufacturing Co., which went through 218 feet of sand, silt, and gravel before reaching bedrock. The valley must have been at least 218 feet deeper than it is now. That this great depth did not extend across the whole width of the valley is shown by wells Nos. 44, 55, and 71 (see Pl. III), which reach rock at moderate depths.

The hill in the northwest corner of the town, known locally as Camp Ground Hill, has a sandstone core overlain by 5 to 25 feet or more of till. The sandstone here is believed to be coarser and better cemented than that underlying the sand plain and therefore to have resisted erosion more successfully. The smoothly rounded outline

of this hill is due to the ice sheet, which wore off the projections and filled the depressions with till. The hill in the southwest corner of the town, known locally as Redstone Hill because the red sandstone crops out at several points on it, is of similar character.

The eastern part of Plainville is a high ridge held up by hard and thick sheets of resistant trap rock. The uniform sedimentation by which the red sandstone and shale were laid down was interrupted three times by the outpouring of sheets of lava which cooled to form the basalt sheets or trap ledges. The whole mass—sandstone, shale, and trap—was later broken by earth movements into huge blocks that were at the same time tilted to the east. The upturned edges of the trap sheets form ridges of considerable topographic prominence, because they resist erosion more successfully than the sedimentary rocks. The middle sheet is the thickest (400 to 500 feet) and therefore the most prominent and forms the high cliffs east of Plainville. Below and separated from it by several hundred feet of sandstone and shale is the thinner lower sheet (about 200 feet thick), which as it crops out on the face or the cliff side of the "Main" sheet is called the "Anterior" sheet. In some places it makes a small cliff below the main cliff. North of the Quinnipiac it is more prominent than to the south and forms a line of low hills separated from the main ridge by a shallow valley. The upper or "Posterior" trap sheet does not crop out in Plainville.

The ridge of trap is not continuous but is cut by Cooks Gap, a gorgelike valley, 200 to 300 feet deep. As there is no evidence of fracturing or faulting,[60] it is probable that formerly Pequabuck River flowed across the trap sheet at this point and cut the gorge. Later the Quinnipiac, which had the advantage of flowing in a bed of softer rocks, cut its head back and captured the flow of the upper portion of this big river and turned it southward. At the end of the glacial epoch the sand plain was built up in such a way as to turn the Pequabuck northward. (See Farmington report, p. 120.)

Two streams flow across Plainville, Quinnipiac River, which rises in New Britain, flows westward into Plainville and then southward into Southington, and Pequabuck River, which rises in Bristol, flows eastward into Plainville and then northward into Farmington. The divide between these streams is part of the sand plain and is only about 20 feet higher than the stream levels. A float measurement of Pequabuck River made half a mile north of the railroad junction Sept. 22, 1915, indicated a flow of about 30 second-feet. Further figures on the flow of the Pequabuck are given in the Bristol report (p. 84).

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[60] Davis, W. M., The Triassic formation of Connecticut: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, p. 176, 1898.

WATER-BEARING FORMATIONS.

Two kinds of bedrock are recognized in Plainville—the sedimentary sandstone and shale and the igneous trap rock.

Trap rock.—Trap rock underlies the elevated portions of Plainville east of the broad sand plain. There are two classes of openings in the trap. Bubbles of gas escaping from the lava have formed vesicles in the upper portions of the sheets. These are unimportant as bearers of water, as they do not interconnect. In addition there are many cracks or joints developed by shrinkage as the rock cooled. They are mainly at right angles to the cooling surfaces of the trap sheets and are very numerous near the contact, but many of them do not extend far into the sheet. Other cracks and fissures were formed by the jarring and crushing that accompanied the tilting of the rocks. Many of the fissures carry water which has percolated directly or indirectly into them from the soil above. This water may be recovered by drilling into the rock, as was done in Mr. Frank Williams's well (No. 41, Pl. III).

Sandstone and shale.—The part of Plainville west of the lower trap sheet is underlain by red shale and sandstone, some of which is relatively hard and coarse, and some of which is softer and of finer grain. These rocks carry considerable water, in joints and fissures and in the interstices between the grains of the coarser beds. Mr. Beckwith's drilled well (No. 17, Pl. III) draws a good supply from the sandstone, probably from fissures rather than from pores. The fissures are less abundant in depth than near the surface, and, as Gregory[61] has shown, the probability of a satisfactory supply is far greater in the first 250 or 300 feet than at greater depths. A concrete example of this is the Trumbull Electric Manufacturing Co.'s well (218 feet to rock, 1,008 feet total depth) which procured a flow of 17 gallons a minute from a fissure at about 300 feet, but got no more water in the remaining 700 feet. A large charge of explosives was set off at a depth of 500 feet, in the hope of opening a connection to possible adjacent water-bearing fissures, but this was unsuccessful and the well was abandoned. It is possible that some fissures were cut by the drill, but that on account of the great pressure of the overlying rock they are so narrow as to be valueless as water carriers.

Till.—The surface material on Camp Ground Hill, Redstone Hill, and the trap ridges is till except where ledges crop out. Till is a mixture of débris of all kinds of rock materials in fragments of all sizes, ground and tumbled together by the moving ice. In general the very fine particles are the most abundant, and as they are closely packed they make the till tough and hard. Some of the boulders

[61] Gregory, H. E., and Ellis, E. E., Underground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 132, 1909.

and pebbles show the effect of ice action by their subangular forms and the presence of glacial striae or scratches. Wells dug in till have a small amount of water that seeps slowly into them from the fine pores. The depth to which wells in till must be dug to get a reliable supply of water depends in part on the character of the till but chiefly on the topographic situation. Twelve wells dug in till were measured in Plainville. The depth to the water level in these averaged 8.6 feet and ranged from 7.7 feet in well No. 43 (see Pl. III) to 23 feet in well No. 18. Information as to the reliability of six wells was obtained, and five of them are said never to fail. Mr. Weeden's well (No. 43) is said to fail, and this is to be expected, as it is situated on a steep slope from which the water drains rather easily.

Stratified drift.—In the discussion of the surface features of Plainville it was shown that the sand plain consisted of well-washed and stratified sand and gravel. In most places the top 2 or 3 feet is a loamy sand, below which is cleaner sand and gravel. The sand is more abundant than the gravel and is in the main moderately fine

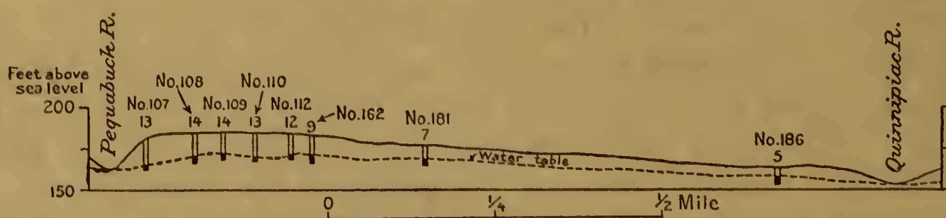


FIGURE 27.—Profile of water table from Pequabuck River southward through Plainville to Quinnipiac River.

and suitable for mortar or cement. The gravel pebbles are for the most part from half an inch or smaller up to an inch in diameter.

The interstices below a certain depth are filled with water which has fallen as rain, and the top of the saturated zone is known as the water table. Its depth depends on the amount of rainfall and the opportunity the water has to escape. The wells along West Main Street, the first street south of and parallel to Pequabuck River, have a depth of about 16 feet. On Broad Street, the next south, the depth is 11 to 12 feet. The wells on the connecting streets are found to be deeper the nearer they are to the river. South of Broad Street the depth decreases for about a mile but again increases near Quinnipiac River. The depths to water in a number of wells along the line *A–A′* on the small map (fig. 28) have been plotted in the section (fig. 27) and a dotted line drawn to show the effect of Pequabuck and Quinnipiac rivers in depressing the water table.

Measurements of 182 wells dug in stratified drift were made in Plainville. The depth to water in them ranged from 4.2 feet in well No. 102 (see Pl. III and fig. 28) to 48 feet in well No. 38 and averaged 15.2 feet. Information as to the reliability of 36 wells was obtained. Of these 31 were said to be nonfailing and 5 were said to fail. Well No. 57 was dry when visited on September 4, 1915.

RECORDS OF WELLS AND SPRINGS.

In the following tables the numbers in the first column refer to the serial numbers shown on the maps—Nos. 1 to 43 on Plate III and Nos. 44 to 199 on figure 28. A few of the wells shown in figure 28 are also plotted on Plate III to indicate the relative position.

Dug wells ending in till in Plainville.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1	....	Hilltop..	385	14.2	11.0	Windlass and house pump.	
2	....	...do....	385	17.4	12.1	Chain pump........	
18	....	Slope...	235	28.4	23.0	Windlass............	Tiled; unfailing.
19	....	Plain...	235	18.2	12.9	Deep-well pump and pump in house.	Unfailing.
19a	....	...do....	230	18.6	12.6	Chain pump........	Do.[a]
20	....	...do....	225	16.6	12.6	Windlass............	Do.
43	C. W. Weeden...	Slope...	330	11.3	7.7	House pump........	Fails.
191	....	Plain...	200	14.2	11.3	Chain pump........	Unfailing.

[a] 300 feet northeast of well No. 19.

Dug wells ending in stratified drift in Plainville.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
4	....	Plain...	245	17.6	15.2	....	Abandoned.
5	....	...do....	245	27.0	24.5	Chain pump........	Unfailing.[a]
5b	....	...do....	200	24.0	20.9	....	Do.
8	....	...do....	205	16.1	15	Windlass rig........	Unfailing; tiled.
9	....	...do....	200	17.2	12.4	....	Unfailing; abandoned.
10	....	...do....	190	17.6	15.4	Chain pump........	Unfailing; rock bottom.
11	....	Slope...	215	16	14	....	About 5 feet in rock.
12	....	...do....	195	16.5	12.7	Chain pump........	Unfailing.
13	Peter Nystrom..	Terrace.	220	43.1	41.4	Windlass rig........	Do.
14	....	Plain...	200	17.5	9	([b])...............	
15	....	...do....	205	18.4	17.2	....	Abandoned.
15a	....	...do....	210	20.8	17.9	Chain pump........	([c]).
16	G. A. Beckwith .	...do....	225	23.1	21.3	Windlass rig........	Tiled; fails.
21	....	Slope...	195	17.2	14.7	....	Unfailing.
22	....	Plain...	190	26.9	23.4	Chain pump........	Do.
23	Reuben Day....	...do....	195	18.6	15.1	Deep-well pump and house pump.	Fails; for analysis see p. 175.[d]

[a] Measurement given was made Sept. 4, 1914; on Sept. 31 the well had 2.3 feet of water.
[b] No rig.
[c] East of well No. 15 and just across the street.
[d] Fourteen measurements of this well were made in 1914, as follows:

Date.	Depth to water (feet).	Date.	Depth to water (feet).	Date.	Depth to water (feet).
Aug. 15..............	15.1	Oct. 19..............	17.3	Oct. 29..............	17.5
Sept. 4..............	15.6	21..............	17.3	31..............	17.5
21..............	16.5	23..............	17.3	Nov. 2..............	17.6
Oct. 11..............	17.6	25..............	17.4	4..............	17.7
18..............	17.4	27..............	17.4		

Dug wells ending in stratified drift in Plainville—Continued.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
24	Chas. Spaulding.	Plain	195	19.7	16.7	Two-bucket rig and air-pressure system.	Unfailing.[a]
25		Slope	160	9.3	6.6		
26		Plain	200	12.6	4.3		
27		do	205	14.5	10.4		Do.
28		do	205	27.7	25.6		Fails.
29		do	205	26.6	23.6	Two-bucket rig	Unfailing.
30		do	205	41.1	18.4		Do.
31		do	205	13.0	9.8	Pitcher pump	Tiled; unfailing.
33		do	205	20.9	14.8	Windlass rig	Fails.
35		do	210	13.4	10.5	Chain pump	
36		do	200	22.3	13.6	do	
36a		Slope	210	30.0	27.8	Windlass rig	([b]).
37		Plain	195	18.9	17.1	do	
38		Slope	240	50	48		Abandoned
42		Plain	200	25.1	21.7	Windlass rig	Unfailing.
44		do	190	17.6	15.4	Chain pump	Unfailing; rock bottom.
45		Slope	185	22.7	20.1	do	Unfailing.
46		Plain	195	19.2	17.6	Windlass rig	
47		do	190	15.6	8.9	Chain pump	Do.
48		do	210	26.0	22.9	Windlass rig	
49		do	210	23.8	21.3	do	
50		do	205	21.7	16.3	Chain pump	
51		do	210	24.1	19.6	do	
52		do	210	20.1	16.4	do	Do.
53		do	210	26.6	24.1	Windlass rig	
54		do	220	34.4	33.8	do	Do.
55		do	220		28	Deep-well pump	Tiled rock at 28 feet.
56		do	225	26.7	23.2	Chain pump	
57		do	225	19		do	Fails.
58		do	225	24.0	20.4	do	Unfailing.
59		do	220	23.9	23.5	Windlass rig	
60		Slope	205	24.4	18.7	Chain pump	Abandoned.
61		do	205	18.4	15.8	do	Do.
62		do	210	23.7	21.8	Windlass rig	Tiled.
63		do	192	13.4	11.1	Deep-well pump	
64		do	185	12.4	10.8	Chain pump	
65		Plain	180	12.2	10.3	House pump	
65a		do	180	12.8	10.9	Windlass rig	Do.
66		Slope	195	12.3	11.7	House pump	
67		do	215	24.4	24.0	Chain pump	
68		do	220	36.3	32.8	do	
69		do	220	22.9	22.0	do	
70		Plain	195	13.9	10.5	do	
71		do	200	19.4	16.1	Chain pump and house pump.	Unfailing; tiled; rock bottom.
72		do	200	17.8	16.1	Windlass rig	
73		do	200	27.9	14.9	do	Rock bottom.
74		do	195	14.5	13.0	do	
75		do	195	13.6	12.2	Chain pump	Abandoned.
76		do	180	14.2	11.5	Two house pumps	Tiled.
77		do	180	14.9	11.9	Chain pump	
78		do	185	17.3	12.3	Windlass rig	
79		do	190	17.0	13.4	Chain pump	Abandoned.
80		do	190	17.3	13.7	do	
81		do	195	17.7	14.6	do	
82		do	190	21.8	18.8		Tiled; abandoned.
83		do	190	20.0	16.3	Windlass rig	
84		do	185	19.0	16.0	Chain pump	
85		do	185	18.8	16.4	Pitcher pump	
86		do	185	21.0	16.7	Chain pump	
87		do	185	18.0	14.8	Two-bucket rig	
88		do	185	17.6	16.0	Chain pump	
89		do	180	19.4	15.4	do	
90		do	185	18.7	13.9	do	

[a] Five measurements of this well were made in 1914, as follows:

Date.	Depth to water (feet).	Date.	Depth to water (feet).	Date.	Depth to water (feet).
Aug. 15	16.7	Sept. 21	17.8	Oct. 18	18.7
Sept. 4	18.1	Oct. 11	18.8		

[b] Midway between well No. 36 and well No. 38.

Dug wells ending in stratified drift in Plainville—Continued.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
91		Plain	185	16.2	13.7	Chain pump	
92		do	185	16.4	14.5	do	
93		do	185	18.7	13.6	do	Unfailing.
94		do	185	14.0	12.6	Windlass rig	
95		do	185	15.8	13.0	Chain pump	
96		do	180	17.0	15.9	do	
97		do	180	15.2	12.0	do	
98		do	180	12.7	10.3	do	
99		do	180	12.9	11.1	Two-bucket rig	
100		do	180	13.6	11.7	House pump	Tiled.
101		do	180	13.3	10.3	do	Do.
102		do	180	6.4	4.2	Chain pump	Abandoned.
103		do	180	14.1	12.7	do	Do.
104		do	180	13.9	12.9	do	
105		do	180	15.4	11.7	do	
106		do	185	17.0	12.3	House pump	Tiled; abandoned.
107		do	185	15.1	13.2	Windlass	Abandoned.
108		do	185	18.4	13.8	Chain pump	
109		do	185	16.7	14.2	Windlass rig	
110		do	185	15.6	12.8	Chain pump	
111		do	180	13.2	12.3	Windlass rig	Bricked; abandoned.
112		do	185	14.7	10.4	do	Abandoned.
113	E. D. Spellman	do	185	19.8	12.8	do	Unfailing.
114		do	185	16.8	13.6	Chain pump	Do.
115		do	185	15.9	15.2	Windlass rig	Abandoned.
115a		do	185	18.6	14.6	do	Do.[a]
116		do	185	18.7	15.5	do	
117		do	185	17.0	14.4	Chain pump	
118		do	185	16.1	14.1	House pump	
119		do	190	17.9	14.5	Chain pump	
120		do	190	20.4	17.7	House pump	
122		do	195	17.3	16.0	Chain pump	
123		do	190	18.8	16.2	do	
124		do	190	20.0	15.2	do	
125		do	190	18.2	16.0	do	
126		do	190	18.5	16.1	No rig	Abandoned.
127		do	190	23.9	20.2	Chain pump	
128		do	190	20.2	18.1	do	
129		do	190	18.7	16.5	do	
130		do	190	18.1	16.0	House pump	
131		do	190	20.0	19.0	Deep-well pump	
132		do	190	21.3	18.0	Chain pump	
133		do	190	20.0	16.0	do	
134		do	185	19.8	16.5	do	Tiled.
135		do	190	18.0	16.3	Windlass rig	
136		do	190	20.9	18.0	do	
137		do	190	19.5	17.1	do	
138		do	190	18.6	16.9	Chain pump	
139		do	190	20.1	16.8	do	
140		do	190	19.2	16.6		Abandoned.
141		do	190	21.9	18.0	Windlass rig	
141a		do	190	19.8	16.7	do	([b]).
141b		do	190	20.2	16.9	Chain pump	([c]).
142		do	185	20.6	17.2	do	
143		do	185	20.0	18.2	do	
144		do	185	21.3	18.8	do	
145		do	190	19.8	18.2	Windlass rig	Abandoned.
146		do	190	23.3	17.8	do	
147		do	190	21.2	17.3	do	Do.
148		do	190	18.3	16.7	Chain pump	
149		do	185	13.3	12.5		Do.
150		do	185	13.0	11.4		Do.
151		do	190	15.6	12.9	Chain pump	
152		do	190	18.9	15.7	do	
153		do	190	18.2	17.0	do	
154		do	190	16.7	14.0	do	Tiled.
155		do	190	14.4	14.1	do	Do.
156		do	190	18.3	14.3	do	
157		do	190	13.2	11.7	do	Do.
157a		do	190	13.5	11.4	do	Tiled; unfailing.
158		do	190	14.6	12.3	House pump	
159		do	185	15.1	11.6	do	Tiled.
160		do	185	19.2	14.8	Windlass rig	
161		do	185	13.2	11.3	Chain pump	
162		do	180	13.0	9.1	do	Abandoned.
163		do	180	12.5	10.5	do	

[a] 75 feet east of well No. 115.
[b] 100 feet east of well No. 141.
[c] 200 feet east of well No. 141 and at corner house.

Dug wells ending in stratified drift in Plainville—Continued.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
164		Plain	180	14.8	9.8	Two-bucket rig	
165		do	180	10.5	9.0	Windlass rig	
166		do	180	11.7	8.7	Chain pump	
167		do	180	11.5	8.5	do	
168		do	180	11.7	7.9	do	
169		do	180	11.2	8.7	do	
170		do	180	13.1	11.1	Pitcher pump	
171		do	180	14.8	10.8	Chain pump	
172		do	180	14.9	11.2	do	
173		do	180	12.7	9.8	do	
174		do	180	13.3	10.3	do	
175		do	175	11.2	7.5	do	Unfailing.
176		do	175	12.5	9.5	do	Tiled; abandoned.
177		do	180	12.2	9.5	do	Tiled.
178		do	180	11.5	8.5	do	Do.
179		do	180	10.4	9.2	do	
180		do	180	10.6	7.9	do	
181		do	175	11.3	7.3	do	
182		do	180	12.7	10.4	do	
183		do	190	20.8	13.3	do	
184		do	185	13.0	9.2	do	Unfailing.
186		do	165	9.9	4.6	Windlass rig	Abandoned.
187		do	175	15.8	5.7	Chain pump	Unfailing.
188		do	175	11.7	7.8	House pump	Unfailing; tiled.
189		do	170	8.1	4.5	Pitcher pump	Tiled.
192		do	160	11.0	9.7		Abandoned.
193		do	170	15.4	10.7	Windlass rig	
194		do	160	7.9	6.6		Unfailing.
196		do	165	13.8	10.7	Rope and bucket	
197		do	175	10.1	4.8	Windlass rig	Tiled.
198		do	190	17.7	16.2	Chain pump	
199		do	195	18.8	15.9	do	

Driven wells in Plainville.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Diameter.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	
6	Frederick Wheeler	Plain	200	46			For analysis see p. 175.[a]
7	Jeremiah Randall	do	215				Dug well deepened by a drive pipe; unfailing.
32	Plainville Water Co.	do	200	25–30		3	Unfailing; see description, p. 177.
34		do	200	12–15			Two wells.
121a	Trumbull Elec. Mfg. Co.	do	190	33			Battery of wells.
185		do	170	6 or 8			
195		do	170		25		Windmill draws about 4 gallons a minute.

[a] Supply is steady. The pump cylinder is in a pit 15 feet deep with the following sections: 3 feet loam, 6 feet sand, 6 inches cobbles, 1 foot hardpan, 4 feet 6 inches fine sand.

Drilled wells in Plainville.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
17	G. A. Beckwith.	Terrace	230	100	35	8	2½	Sandstone	For assay see p. 175.
41	Frank Williams.	Slope	240	170	123	6	2	Trap	Do.
121	Trumbull Elec. Mfg. Co.	Plain	190	1,008	218	10, 8, 6	16–17	Sandstone and shale.	([a]).

[a] Water in unconsolidated drift was cased off. A fissure at 300 feet supplied the only water from solid rock. Abandoned for a group of driven wells.

Springs in Plainville.

No. on Pl. III or fig. 28.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Remarks.
			Feet.	° *F.*	
3	Wm. J. Johnson	Slope	260		Unfailing; piped to house and horse trough.
39		...do	230	51	Supplies four families by gravity.
40	R. S. Morey	...do	255	57	Unfailing; gravity supply; for assay see p. 175.
190		...do	210	57	A basin 5 feet square by 2 feet deep.

QUALITY OF GROUND WATER.

The results of two analyses and three assays of samples of ground water collected in Plainville are given below. The waters are low in mineral content except No. 41, which is moderately mineralized. Nos. 6 and 40 are very soft, and the rest are soft. The waters are carbonate in type, but in No. 17 the alkaline earths exceed the alkalies. In respect to mineral content they are suitable for domestic use. Nos. 6, 23, and 40 will deposit but little scale in boilers. Although the other waters will deposit more scale, the amount will not be excessive, and all are considered good for boiler use. Corrosion would probably not occur through the use of any of the waters, although No. 23 is doubtful in this respect. Both chloride and nitrate are abnormal in No. 23.

Chemical composition and classification of ground waters in Plainville.

[Parts per million; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding numbers on Pl. III or fig. 28; see also records corresponding in number, pp. 171–175.]

	Analyses.[a]		Assays.[b]		
	6	23	17	40	41
Silica (SiO_2)	19	7.5			
Iron (Fe)	.05	.25	0.40	Trace.	Trace.
Calcium (Ca)	10	16			
Magnesium (Mg)	1.3	4.2			
Sodium and potassium (Na+K)[c]	12	29	7	27	36
Carbonate radicle (CO_3)	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	46	68	68	100	173
Sulphate radicle (SO_4)	8.2	12	Trace.	5	5
Chloride radicle (Cl)	5.0	26	10	10	4
Nitrate radicle (NO_3)	3.0	18			
Total dissolved solids	73	138	[c] 90	[c] 120	[c] 180
Total hardness as $CaCO_3$[c]	30	57	[d] 56	[d] 47	[d] 81
Scale-forming constituents[c]	51	62	70	60	95
Foaming constituents[c]	32	78	20	70	100
Chemical character	Na-CO_3	Na-CO_3	Ca-CO_3	Na-CO_3	Na-CO_3
Probability of corrosion[e]	N	(?)	N	N	N
Quality for boiler use	Good.	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.
Date of collection (1915)	Nov. 16	Nov. 11	Nov. 19	Nov. 16	Nov. 16

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Computed.
[d] Determined.
[e] Based on computed value; N=noncorrosive; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

Plainville has been supplied since 1884 by the Plainville Water Co. At first the water was drawn entirely from Crescent Pond, a reservoir in the northeast corner of Southington, covering 58 acres and having

FIGURE 28.—Map of Plainville. *A–A'*, Line of section in figure 27. Numbers indicate wells referred to in text and tables.

a capacity of 160,000,000 gallons. The reservoir is fed by springs and was made by a dam 800 feet long and 25 feet in maximum height. The spillway is 234 feet above the Square in Plainville, so there is a head of 100 to 116 pounds to the square inch. The water is distrib-

uted by gravity through 12 miles of main to 58 fire hydrants and 437 service taps. Mr. J. N. McKernan, the superintendent, estimates that 2,250 of the 2,882 people in the town are served. The average daily consumption in summer is estimated at 300,000 gallons.

About 1909 trouble was had with algal growths, and the company decided to install an auxiliary ground-water supply. After tests at several points a site was chosen east of the village and between the railroad and Quinnipiac River, at the point indicated on the map (Pl. III) as No. 32. The studies made here showed that the ground water moves in a southerly direction toward the Quinnipiac. Thirty 3-inch driven wells were put down, in two rows of 15 each. The depth ranges from 25 to 30 feet. Tests made with a sewer pump indicated a capacity of 40 gallons a minute for each well. The wells are connected to a suction main that carries the water to a three-cylinder 7½ by 12 inch Deane pump, driven by a 50-horsepower De la Vergne hot-tube crude-oil engine. Water is pumped directly into the main, and the excess is backed up into a small covered reservoir at Crescent Lake. The pump has a capacity of 30,000 gallons an hour and if run 10 to 12 hours a day provides water enough for 24 hours. Despite the heavy draft there has been no permanent reduction of the ground-water supply, and though the water level is depressed by the day's pumping it recovers its normal level overnight.

The water is excellent, though a little harder than the reservoir water, but this disadvantage is more than compensated by the elimination of the algae and their "fishy" odor and taste. At times during the pumping season the water drawn from the tap has a milky color due to minute air bubbles sucked in with the water, but it quickly clears on standing.

PLYMOUTH.

AREA, POPULATION, AND INDUSTRIES.

Plymouth is a highland manufacturing town in the southwestern part of Litchfield County, north of Waterbury and west of Bristol. The principal settlements are Plymouth, Terryville, and Pequabuck; the last two are continuously built up. At these places there are stores and post offices. Tolles, Hancock, and Greystone are small settlements and with the farming districts are served by rural delivery. The Highland division of the New York, New Haven & Hartford Railroad crosses the southeastern part of the town and has a station at Pequabuck, called the Terryville station, and flag stations at Wheton's, Hancock, and Tolles. Thomaston and Reynolds Bridge, on the Naugatuck division, are not far away in the town of Thomaston. There is a stage line between Terryville, Plymouth village, and

Thomaston, and trolley connection from Terryville to Bristol, Plainville, and more distant points.

The area of Plymouth is 22 square miles, of which nearly half is wooded. There are 90 miles of roads, including 4 miles of the bituminous-macadam State trunk line through Plymouth village, Terryville, and Pequabuck, connecting Thomaston with the cities to the east. The 86 miles of dirt roads are well kept up and are for the most part good except for the unavoidable grades.

In 1795 Plymouth was taken from Watertown and incorporated. Its extent and organization have remained unchanged except for the separation of 13 square miles in 1875 to make Thomaston. Formerly Plymouth village was a more important place than Terryville, but the manufacturing industries of Terryville, which began to flourish about 1835, have given it first rank. As is shown by the table below the population has generally shown a steady increase in each census period. In the decade from 1870 to 1880 there is a large apparent decrease, due to the separation of Thomaston. As Thomaston had a population of 3,255 in 1880, the territory as a whole gained. The population in 1920 was 5,942.

Population of Plymouth, 1800–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1800	1,791	1840	2,205	1880	2,350
1810	1,882	1850	2,568	1890	2,147
1820	1,758	1860	3,244	1900	2,828
1830	2,064	1870	4,149	1910	5,021

[a] Connecticut Register and Manual, 1915, p. 655.

The principal industries of Plymouth are agriculture, cutting of domestic lumber, and the manufacture of locks, wood screws, castings, and thermometers.

SURFACE FEATURES.

Plymouth is essentially a plateau, deeply dissected in the south and less deeply in the north. From the lowest point, in a valley west of Greystone, 390 feet above sea level, there is a range in elevation of 610 feet to the highest point, a flat hilltop in the southeast corner of the town, 1,000 feet above sea level. Pine Hill, south of Plymouth village, Holts Hill, and an unnamed hill north of the village are of about 980 feet elevation and mark the surface of the dissected plateau.

In the valleys of Poland River and Marsh Brook, in the northeastern part of the town, and Todd Hollow Brook, in the southern part, fair-sized flood plains of stratified drift have been built. The deposits along Todd Hollow Brook were formed of the excess load of detritus that the brook and its tributaries carried in their upper

reaches but that they had to drop in the flatter, more slowly flowing lower reaches. The deposits of the plains of Poland River and Marsh Brook, though continuous with the thick deposits of the Pequabuck Valley (see Bristol report, p. 83), extend to higher elevations and are probably flood-plain rather than delta deposits. They are analogous to those of Todd Hollow, but are probably older—that is, of late glacial rather than postglacial age.

Plymouth is on the divide between the Connecticut and Naugatuck drainage basins. Pequabuck River, with its principal tributary Poland River, drains about 6 square miles in the northeastern part of the town. A float measurement made June 2, 1915, on Poland River a short distance above the juction of Marsh Brook, showed a flow of 3⅓ second-feet. A narrow strip along the west boundary is drained by a number of small brooks that empty into Naugatuck River, but the rest of the town is drained by Todd Hollow Brook. A float measurement on the west branch of this stream made a mile north of Hancock on May 29, 1915, showed a flow of 2½ second-feet.

WATER-BEARING FORMATIONS.

Schist and gneiss.—Four varieties of bedrock have been recognized in Plymouth—the Hoosac schist, Thomaston granite gneiss, amphibolite, and Waterbury gneiss.[62]

The oldest of these is the Hoosac schist, in which mica and quartz are the dominant minerals, with garnet, staurolite, feldspar, and other minerals as accessories. The mica is in the form of parallel flakes and gives the rock its cleavable schistose structure. The rock ranges from light to dark gray in color, and in many places the mica gives it a glistening, silvery luster. In some places there is a great abundance of thin injected sheets and dikelets that quite alter the character of the schist.

The Thomaston granite gneiss, so called because of its excellent exposures in the town of Thomaston, is a medium fine-grained granite of light color, composed of feldspar, quartz, and mica, with small amounts of accessory minerals. In some places mashing has segregated the mica into dark-colored bands that give the rock a gneissic texture. There are two areas of this granite gneiss in Plymouth—one along the northern part of the west boundary and one in the southwest corner. The rock has been intruded into the schists and is probably related to the thin sheets and dikelets in the schist.

There have also been intrusions of hornblende diorite that have been metamorphosed to amphibolite, a dark-colored rock of gneissic texture, consisting essentially of feldspar and green hornblende with

[62] Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 7, 1907.

subordinate amounts of garnet, quartz, and epidote.[63] This rock is found both as massive intrusions of moderate size and as thin dikes and sheets in the schist. There is a large covering, about 100 acres, a mile southwest of Pine Hill.

The term Waterbury gneiss has been applied to a rather varied group of rocks formed by the injection into the schists of great amounts of granitic and quartzose material and lesser amounts of hornblendic lavas. The rock is in a sense transitional between the massive granite gneisses and amphibolites and the schist.

The four bedrock formations of Plymouth are essentially alike as regards their capacity for containing and yielding ground water. A little water is carried in minute pores between the constituent grains and flakes, but it is insignificant in amount. These rocks are cut by numerous joints and fissures made by the jostling and crushing to which they have been subjected. These openings are abundant near the surface but less so in depth because of the compression of the great weight of overlying rock. Water which has fallen as rain and soaked into the ground will work its way into the complicated system of fractures and may be recovered by means of drilled wells, five of which were visited in Plymouth. The wells of the Terryville Water Co. have been abandoned because the supplies they yielded were not sufficient for the needs of the company.

Till.—Over the bedrock of most of Plymouth is a mantle of glacial till 40 feet or more in maximum thickness. It is a heterogeneous mixture of rock débris of all sizes from the finest of rock flour up to boulders weighing tons, made by the plowing and scraping action of the glacier and finally plastered over the bedrock. The term "hardpan" often applied to till is very appropriate, for the rock flour binds the other constituents together and makes a very tough deposit. Despite its compactness and toughness till has considerable pore space and contains in most places and seasons ground water enough to supply domestic dug wells. Wells in disadvantageous positions, as on steep slopes or where the till is thin, will be likely to fail. Measurements of 112 wells dug in till were made in Plymouth, and the depth to water was found to average 10 feet and to range from 1.6 feet in well No. 124b (see Pl. III) to 28.7 feet in well No. 97. The reliability of 95 of these wells was ascertained; 54 were said never to fail and 41 were said to fail. Careful studies of Mr. H. W. Cleaveland's well (No. 12) show the slowness and smallness of the supply in till wells. (See p. 49.)

Stratified drift.—The surface material in certain other parts of Plymouth, as shown on the map (Pl. II) and in the section on surface features, is stratified drift. This deposit has been made in large part by the reworking of the till by running water, so that the finer

[63] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, p. 112, 1906.

grains of clay, rock flour, and silt have been removed from the sand and gravel. Although the total pore space in the stratified drift is not much greater than that of the till, the individual pores are larger and allow more rapid circulation of the ground water. Wells in stratified drift give more abundant and more reliable supplies in general than till wells. The average depth to water in the 27 wells dug in stratified drift that were measured in Plymouth was 12 feet, and the range from 2.6 feet in well No. 115 (see Pl. III) to 19 feet in well No. 135. Of these wells 18 were said never to fail and 3 were said to fail; the reliability of the other 6 wells was not ascertained.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Plymouth.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1		Slope	740	16.3	9.0	Windlass rig	Rock bottom; fails.
2		do	730	20.8	9.7	do	
3		do	820	28.0	12.5	House pump	Unfailing.
4		Hilltop	905	13.6	6.0	Windlass rig and house pump.	Fails.
5		do	905	25.3	8.1	do	Do.
6		do	905	15.7	7.8	Windlass rig	Do.
7	J. Nodine	Slope	810	7.0	2.1	do	Unfailing.
8		do	700	15.0	7.9	do	Do.
10		do	730	12.1	4.3	Pitcher pump and house pump.	Do.
11		do	720	16.2	15.2	Windlass rig	
12	H.W.Cleaveland	do	700	24.0	15.2	Air-pressure system	Unfailing; for analysis see p. 184.[a]
13		do	630	9.1	2.6	Windlass rig	Unfailing.
14		do	580	10.9	4.9	Windlass rig and two house pumps.	Do.
15		do	620	20.5	15.0	Windlass rig	Do.
16		do	680	14.9	7.8	Windlass rig and house pump.	Do.
17		do	760	19.6	8.2	Two house pumps	Do.
18		do	700	17.0	13.6	Windlass rig	Fails.
19		do	725	21.7	13.5	do	Do.
20		do	725	11.0	3.8	do	Unfailing.
21		do	710	12.6	6.9	Chain pump	Fails.
22		do	790	22.4	16.5	Windlass rig	Unfailing.
23	J. Schrobback	Hilltop	940	20.0	14.0	do	Fails.
24		Slope	945	18.4	17.1	do	Do.
25		do	930	14.7	11.1	do	Do.
27		Hilltop	760	17.9	9.4		Do.
29		Slope	765	20.	17.	Windlass rig	Do.
30		do	760	20.3	12.8	do	Unfailing.
31		do	760	13.2	5.3	do	Do.
32		Plateau	740	10.4	4.2	do	Fails.
34		do	750	15.9	11.3	do	Do.
35		Slope	700	20.3	15.3	Chain pump	Do.
36		do	920	13.9	7.9	Windlass rig	Do.
37		do	870	12.1	9.4	Wheel and axle rig	Do.
38		Plateau	860	19.8	11.7	Windlass rig	Unfailing.
39		do	970	25.0	18.0	(b)	
40		do	970	19.7	10.4	Chain pump	Do.
41		do	970	21.9	13.4	Windlass rig	Do.
42		Slope	885	20.3	13.8	Chain pump	Do.
43		do	795	15.9	9.9	Windlass rig	
44		do	790	21.3	10.6	Chain pump	Do.
46		do	745	18.4	12.8	do	Do.
47		Hilltop	785	12.1	3.9	Windlass rig	
48		Slope	770	13.8	6.7	do	Do.
49	J. H. Croft	do	770	15.4	8.8	Two house pumps	Fails; for assay see p. 184.[c]
50		Hilltop	845	17.4	7.4	Wheel and axle rig	
51	E. A. Beach	do	845	19.0	9.5	Windlass rig	Unfailing; for assay see p. 184.[d]

[a] Pumping test made, see p. 49.
[b] No rig.
[c] Rock bottom.
[d] Dug 7 feet into rock. Water flows in from a crack.

Dug wells ending in till in Plymouth—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
52		Hilltop	840	17.7	10.0	Windlass rig	Fails.
53		Slope	820	13.2	7.6	do	
54		Ridge	840	18.4	10.2	do	
55		Slope	810	23.4	9.4	do	Unfailing.
56		do	800	13.9	6.5	do	Do.
57	W. J. Church	do	850	28.1	9.9	do	Do.
58		do	840	22.2	6.4	House pump	Do.
59		do	760	12.0	5.9	Windlass rig	
60		do	710	24.8	8.7	Chain pump	
61		Plain	700	12.0	4.0	One-bucket rig	Do.
62		do	700	25.5	9.6	Windlass rig	Do.[a]
63		do	700	22.7	11.0	House pump	Do.
64		Slope	745	17.9	13.9	do	Rock bottom; unfailing.
65		do	750	13.2	10.0	do	Rock bottom; fails.
68		do	640	18.9	14.0	Windlass rig	
72		do	660	26.3	13.1	do	Unfailing.
73		Slope	820	11.3	3.7	do	Do.
74		do	880	24	19	do	Do.
75		Hilltop	870	21.8	8.4	do	Do.
77		Slope	890	13.9	6.7	do	Do.
78		do	870	11.0	6.0	do	Do.
79		Hilltop	825	18.6	9.9	do	Fails.
80		do	825	15.3	8.2	do	Do.
82		Slope	720	27.9	10.4	do	
83		do	740	14.6	5.4	do	
89		do	780	15.6	8.2	House pump	Tiled.
90		Plain	645	27.0	25.0	Windlass rig	Abandoned; fails.
91		Slope	720	14.9	4.4	do	Unfailing.
92		do	640	10.8	7.7	Sweep rig	Do.
93		do	695	14.0	8.9	do	Fails.
93a		do	730	17.6	11.6	Windlass rig	Do.[b]
94		Plain	725	11.3	4.4	do	Do.
95		do	720	14	4	Gravity system	Unfailing.
96		do	730	12.5	10.0	Windlass rig	Fails.
97		do	730	30.9	28.7	Deep-well pump	Do.
98		do	705	13.7	11.9	Windlass and counterbalance rig.	Do.
99		Slope	720	13.6	7.5	do	Unfailing.
110		Plain	640	28.8	26.1	Windlass rig	Fails.
112		do	715	18.1	14.4	do	Do.
114		do	630	17.2	13.9	Chain pump	Unfailing.
115		Slope	635	9.4	2.6	(c)	Do.
117		do	855	14.3	9.7	Two-bucket rig	Fails.
121		do	715	20.7	13.2	Windlass rig	Unfailing.
122		do	565	8.0	2.8	do	Do.
123		Swale	560	19.3	13.5	do	Do.
124		Slope	580	18.0	12.8	Windlass rig and house pump.	Do.
125		do	760	13.1	5.2	Windlass rig	
126		Plateau	850	20.1	13.5	Two house pumps	Do.
130		Slope	580	27.6	22.0	Windlass rig	Fails.
132		do	720	19.5	11.0	do	Unfailing.
133		do	600	9.9	4.9	do	Fails.
139		do	500	25.7	13.6	Chain pump	Unfailing.
140		do	520	10.2	6.3	Windlass rig	Do.
141		do	460	9.8	6.6	Pitcher pump	Do.
142	G. R. Duff	Plateau	880	20.6	8.7	Windlass rig and house pump.	Fails; for assay see p. 184.[d]
142a	do	do	895	12.5	5.0	(c)	Unfailing.[d]
142b	do	do	875	9.0	1.6	(c)	Fails.[d]
142c	do	do	880	15.2	5.0	(c)	Do.[d]
143		Slope	635	8.5	5.4		
144		do	810	16.0	11.9	Sweep rig	Do.
144a		do	810	12.7	7.8	do	Unfailing.[e]
145		do	780	9.3	3.0	Windlass rig	Do.
146		do	645	14.4	9.8	do	Fails.
147		Plain	570	7.6	3.2	do	Do.
148		Plateau	770	21.1	16.6	do	Rock bottom; fails.
150		Slope	740	16.6	12.7	do	Unfailing.
151		do	740	17.9	15.6	do	Do.
153		do	790	21.4	21.0	(c)	

[a] Depth of water never less than 4 feet; sometimes rises to surface.
[b] 200 feet east of well No. 93.
[c] No rig.
[d] Well No. 142 is at the house. Well No. 142a is 1,350 feet south of No. 142. Well No. 142b is 300 feet northeast of No. 142. Well No. 142c is 400 feet west of No. 142.
[e] Is 100 feet northwest of well No. 144.

Dug wells ending in stratified drift in Plymouth.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
66	....	Slope...	685	28.8	15.6	Chain pump........	20 feet in rock.
67	....	...do....	690	27.1	16.4	Windlass...........	Unfailing.
70	....	Plain...	670	10.4	5.1	.....do...........	Do.
71	....	...do....	670	10.6	6.8	House pump........	Do.
85	....	Slope...	670	14.6	9.9	Windlass...........	Do.
87	....	Swale...	639	13.0	7.9	.....do...........	Abandoned.
88	....	Plain...	615	11.0	7.9	Chain pump........	Unfailing.
100	....	...do....	785	18.4	14.3	Windlass and house pump.	Do.
101	....	...do....	785	18.9	13.9	Windlass...........	Do.
102	....	Swale...	660	21.2	18.2	.....do...........	Do.
103	....	Plain...	620	10.1	8.2	Chain pump........	Do.
104	....	...do....	645	13.6	7.9	Windlass...........	
106	....	...do....	625	9.4	5.7	(a)...........	Do.
107	....	...do....	615	19.7	16.0	Chain pump........	
108	....	...do....	620	15.9	13.4	Two house pumps ..	Do.
109	....	Slope...	625	20.8	17.8	Windlass...........	Do.
113	....	Plain...	650	10.5	7.8	Chain pump and house pump.	Do.
116	....	...do....	630	24.0	18.1	House pump........	Do.
127	....	Slope....	580	19.8	15.2	Windlass...........	Fails.
129	....	...do....	550	11.9	6.7	.....do...........	Do.
131	C. Cleaveland....	...do....	535	16.7	11.8	.....do...........	Unfailing.
135	....	Plain...	490	21.1	19.0	.....do...........	Fails.
136	Michael Cronin..	...do....	495	18.2	13.9	.....do...........	
137	J. M. Scarritt....	Slope...	500	20.0	14.4	.....do...........	Unfailing.
152	....	...do....	700	19.8	16.0	.....do...........	

a No rig.

Drilled wells in Plymouth.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
33	E. R. Lackmore.	Knoll...	750	100	....	....	1	Gneiss ..	Bored well.a
69	F. A. Wellman .	Slope...	730	108	11	6	1½	Schist...	Cost $5 per foot.
76	Terryville Water Co.	...do....	840	150	20	....	10	...do....	(b).
81	.....do.......	...do....	700	100	30 or 40	....	b 30	...do....	
84	High School....	...do....	690	370	80 or 90	8	(c)	...do.....	
86	E. Grant Austin.	...do....	650	152	47	6	+14	Gneiss..	For analysis see p. 184.
118	G. E. Holt.....	...do....	780	100	10	6	1	...do....	Bored well, cost $3 per foot; for assay see p. 184.

a Water enters at depth of 70 feet.
b Water obtained only from the unconsolidated mantle rock.
c 10 gallons a minute at 300 feet depth; 15 gallons a minute at full depth.

Springs in Plymouth.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	° *F.*	*Galls.*	
9	....	Swale.........	560	54	2	Unfailing.
26	Town Farm........	Slope.........	840	49	....	Piped to house.
28	....	Swale	770	(a)	....	
45	....	Slope.........	760	47	....	Pumped from the house.
105	....	Swale.........	630	54	Strong	
119	....	Slope.........	790	49	....	
120	....	...do.........	810	46	....	Piped to house.
128	....	...do.........	580	54	....	Do.
134	S. Johnson........	...do.........	530	53	....	Piped to house; unfailing.
138	....	...do.........	535	47	....	Do.
149	....	Swale.........	760	52	....	Fails; pumped to house.

a 51° in the full run.

QUALITY OF GROUND WATER.

The results of two analyses and four assays of samples of ground water collected in Plymouth are given below. All the waters are low in mineral content except No. 86, which is moderately mineralized. Nos. 86 and 12 are soft; the rest are very soft. The waters are of the calcium-carbonate type except Nos. 86 and 142, which are sodium-chloride and sodium-carbonate waters, respectively. With the exception of No. 86 all the waters are suitable for domestic use, although No. 51 is only fair. There are several objections to No. 86; the chloride and nitrate are exceptionally high for Plymouth and indicate possible pollution, sufficient iron is present to stain porcelain and clothes, and the water has a slightly disagreeable taste. No. 51 also contains a sufficient quantity of iron to be somewhat objectionable in domestic use. Although three of the waters, No. 12, 86, and 49, are on the border line between corrosion and noncorrosion of boilers, all six waters are considered good for use in boilers, because foaming and scale formation would be at a minimum.

Chemical composition and classification of ground waters in Plymouth.

[Parts per million; collected Nov. 20, 1915; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 181-183.]

	Analyses.[a]		Assays.[b]			
	12	86	49	51	118	142
Silica (SiO_2)	14	20				
Iron (Fe)	.25	1.5	0.20	1.5	Trace.	Trace.
Calcium (Ca)	15	16				
Magnesium (Mg)	3.6	5.7				
Sodium and potassium (Na+K)[c]	13	53	1	6	5	12
Carbonate radicle (CO_3)	.0	.0	0	0	0	0
Bicarbonate radicle (HCO_3)	61	65	29	34	65	24
Sulphate radicle (SO_4)	18	5.7	Trace.	5	Trace.	Trace.
Chloride radicle (Cl)	8.0	77	5	5	3	8
Nitrate radicle (NO_3)	Trace.	14				
Total dissolved solids	102	222	[c] 48	[c] 60	[c] 76	[c] 49
Total hardness as $CaCO_3$	[c] 52	[c] 63	28	28	48	6
Scale-forming constituents[c]	64	77	45	45	65	20
Foaming constituents[c]	35	140	([d])	20	10	30
Chemical character	Ca-CO_3	Na-Cl	Ca-CO_3	Ca-CO_3	Ca-CO_3	Na-CO_3
Probability of corrosion[e]	(?)	(?)	(?)	N	N	N
Quality for boiler use	Good.	Good.	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Fair.[f]	Good.	Fair.[f]	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59-61.
[b] Approximations; for methods used and reliability of results, see pp. 59-61.
[c] Computed.
[d] Less than 10 parts per million.
[e] Based on computed value; (?)=corrosion uncertain; N= noncorrosive.
[f] See discussion of quality of water.

PUBLIC WATER SUPPLY.

Terryville has been supplied with water since 1893 by the Terryville Water Co. Water from two small spring-fed reservoirs on Town Hill is delivered by gravity to 10 fire hydrants and 286 private-service connections. The pressure averages about 80 pounds

to the square inch. As these reservoirs do not yield an adequate supply it has been necessary to find auxiliaries. Attempts were made to obtain water by means of drilled wells, of which three were sunk but were unsuccessful. At present a third reservoir on a branch of Pequabuck River west of the village is used, and at some seasons this is further supplemented by pumping from Pequabuck River. A three-stage centrifugal pump driven by a 25-horsepower electric motor is used. Terryville is topographically very poorly situated for the development of public water supplies, as it is about as high as any of the streams that might be used, so that economical delivery is hard to arrange. Poland River, from which an excellent supply might be obtained, is controlled by the Bristol waterworks, and Thomaston controls the headwaters of Todd Hollow Brook.

PROSPECT.

AREA, POPULATION, AND INDUSTRIES.

Prospect is a highland farming town in the north-central part of New Haven County, on the eastern edge of the western highland. The only settlement is the spread-out village known as "the Center." The mail service for the whole town is by rural delivery. The Meriden-Waterbury branch of the New York, New Haven & Hartford Railroad crosses the northeast corner of the town and has flag stations at Prospect Station and at Summit, just across the Cheshire boundary. The New Haven-Waterbury trolley line follows closely the line of the steam road and is the chief means of communication. Prospect has an area of about 15 square miles, of which half is wooded. There are 44 miles of dirt roads, which are kept in as good condition as the rugged topography and sparse population allow.

The territory which now forms Prospect was taken from Cheshire and Waterbury in 1827 and incorporated. Early in the nineteenth century there was some manufacturing of hardware, shoes, and matches at small mills on the streams. These industries have died out because of the competition of bigger concerns elsewhere, and now the people are dependent on agriculture or on employment in neighboring towns. The population in 1910 was 539. The following table shows that the changes in population have been moderate in amount but not constant in direction.

Population of Prospect, 1830–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1830	651	1860	574	1890	445
1840	548	1870	551	1900	563
1850	666	1880	492	1910	539

[a] Connecticut Register and Manual, 1915, p. 655.

SURFACE FEATURES.

Prospect is a dissected plateau whose remnants range in elevation from 800 to 880 feet above sea level. The town has a total relief of 640 feet. The lowest point is where Tenmile River crosses the north boundary, at an elevation of 240 feet above sea level, and the highest point is a flat hill three-quarters of a mile south of the Center, with an elevation of 880 feet. The drainage pattern on this plateau is irregular, but along its eastern margin there is a straight valley occupying an area of relatively soft sandstone between a trap ridge on the east and an area of granite gneiss on the west. Roaring Brook drains the southern part of this valley, and one of the tributaries of Tenmile River the northern part. Probably the drainage prior to the glacial epoch went to the north throughout the length of this valley, but for a while the ice dammed the valley, making a lake in which a considerable thickness of sediments was deposited. The lake found an outlet across a low point in the sag, and by the time the ice had completely retreated the outlet channel had been cut down so deep that the upper part of the valley continued to follow it. Most of the brooks draining Prospect are tributary to Naugatuck River, but some join Mill River and some Quinnipiac River. A rough float measurement of Tenmile River made on May 8, 1915, near the point where it crosses the Cheshire town line indicated a flow of 4.5 second-feet.

WATER-BEARING FORMATIONS.

There are five varieties of bedrock underlying Prospect—the Waterbury gneiss, Hoosac schist, Prospect porphyritic granite gneiss, and the Triassic sandstone and trap.[64]

Trap rock.—The intrusive trap sheet which crops out along much of the western boundary of the central lowland follows the eastern boundary of Prospect for about 3 miles. The town line runs approximately on the crest of the westward-facing cliff formed by the upturned edge of the tilted trap sheet. On account of its inaccessible position and its small areal extent the trap is of little importance as a source of ground water.

Sandstone.—Underlying the trap sheet and dipping with it to the east is several hundred feet of red sandstone which was deposited as a nearly horizontally bedded filling of a great valley that occupied central Connecticut in Triassic time. Not very long after the consolidation or partial consolidation of this filling the trap sheet was forced into it, and still later the whole mass was tilted. Shrinkage of the sediments in drying and of the trap in cooling had un-

[64] Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, 1906.

doubtedly made many cracks and fissures, but more were made by the jarring and crushing incident to the tilting. These cracks are to a large extent filled with water that has percolated in from the overlying surface materials. Wells drilled into the sandstone ought to procure supplies of water from these openings, but no such development has been made in Prospect. It is very likely that the trap sheet acts as a somewhat impervious blanket and prevents the water from seeping out to the east. The sandstone underlies a strip from a few hundred feet to a quarter of a mile wide in the valley west of the trap ridge but crops out only in a few places.

Gneiss and schist.—The Prospect porphyritic granite gneiss crops out here and there in a strip 1½ miles wide lying west of and parallel to the narrow sandstone belt. It is a grayish rock consisting of quartz, feldspar, and mica with small amounts of accessory minerals. The mica crystals or flakes are to some extent concentrated in certain planes in which they are arranged in roughly parallel position so that they give the rock a foliated, gneissic structure. Some of the feldspar crystals have developed into large crystals or phenocrysts, which give the rock its porphyritic character.

The Hoosac schist underlies a belt half a mile to a mile wide west of the granite gneiss area. It is a typical gray schist composed essentially of flakes of mica and grains of quartz with some grains of accessory minerals. The mica flakes in part enwrap the quartz grains but are for the most part roughly parallel and so give the rock its characteristic schistose cleavage and structure. Many thin sheets and dikes of quartzose material have been injected into the schist. The sheets—that is, the injections that follow the cleavage—are the more abundant.

The Waterbury gneiss is somewhat similar to the Hoosac schist and is believed by Gregory [65] to be merely a modification of it. So much of the igneous material has been injected in parts of the schist that its character is completely altered, making rock so different as to be a separate formation. Most of the injections are quartzose, but some are dark hornblendic lavas.

The dynamic forces to which these schists and gneisses have been subjected have made many fissures and joints in them. Water percolates from the saturated parts of the overlying mantle rock into the intricate network of channels. Wells drilled into these rocks are very likely to cut one or more water-bearing fissures within a reasonable distance, and thus obtain a satisfactory supply of water. The Grange and Parsonage wells (Nos. 25 and 26, Pl. III) are in the Hoosac schist. Mr. Hufnagle's well (No. 48) is in the Waterbury

[66] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, p. 100, 1906.

gneiss. The driller described the material from which the water came as trap rock, but it is more probably one of the hornblendic masses.

Till.—Most of Prospect has a mantle of till over the bedrock. The till is a stiff, clayey material with which is mixed a greater or less amount of sand, gravel, and boulders. It is the ground-up débris that the glacier pushed along and plastered over the bedrock. On account of the fineness of much of the material it is a rather impervious deposit. However, it holds water in quantities sufficient for supplying dug wells, but it gives the water out rather slowly. Measurements were made of 68 wells dug in till in Prospect. The depth to water in them ranged from 3.1 feet in well No. 2 (see Pl. III) to 26.3 feet in well No. 45 and averaged 11.4 feet. Of these wells 32 were said to be nonfailing and 21 were said to fail in dry seasons; the reliability of the remaining 15 wells was not ascertained.

Stratified drift.—There are three areas in Prospect where the surface material is stratified drift. Half a mile west of the Center there is a broad, flat depression in which water-borne débris has been deposited. Presumably this material is fine grained and impervious, for the ground is rather marshy. No wells were found in this area, but the ground-water conditions are at least fair. Near the western boundary and parallel to it there is a strip a quarter of a mile wide by three-quarters of a mile long in which there is a somewhat coarser deposit of stratified drift, and along part of the eastern boundary there is a more extensive area. Both of these are in valleys which appear to have been temporarily dammed by the ice sheet as it melted back. Small lakes were formed south of the ice front into which the detritus was washed. Four wells that draw their water from these deposits were measured, and their average depth to water was found to be 13.4 feet.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Prospect.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1	....	Hilltop..	800	17.5	6.8	House pump........	Rock bottom; fails.
2	....	Slope...	755	13.9	3.1	Chain pump........	Unfailing.
3	....	...do....	765	21.3	12.5	Windlass rig........	Do.
5	....	Hilltop..	625	22.6	12.9	Two-bucket rig.....	43° F.; fails.
7	....	Slope...	760	15.4	8	Sweep rig and house pump.	Unfailing.
8	....	...do....	760	22.8	10.3	Windlass rig........	Do.
9	....	...do....	795	11.5	10.0	Two-bucket rig.....	Do.
10	....	Plateau	860	22.8	10.4	.....do..............	Do.
11	Wm. E. Clarke..	...do....	860	21.9	12.2	Chain pump and house pump.	Unfailing; for analysis see p. 191.

Dug wells ending in till in Prospect—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
12		Slope	800	8.9	3.4	Windlass rig	Unfailing.
13		do	805	19.7	12.3	Chain pump	
14		do	825	14.7	5.5	Windlass rig	Do.
15		do	820	15.4	4.4	do	
16		do	650	12.1	2.9	Chain pump	Do.
17		do	720	22.6	19.4	Two-bucket rig	Fails.
18		do	760	17.7	8.9	Chain pump	Do.
19		do	820	22.2	14.2	do	Do.
20		Plateau	865	22.9	12.7	Two-bucket rig	
21		do	865	21.1	11.7	House pump	Do.
22		do	860	12.5	8.9		Do.
22a		do	875	18.3	13.5	Gravity rig	Unfailing.[a]
23		do	865	18.0	8.5	Wheel and axle rig	Do.
24		do	860	27.3	9.6	Windlass rig	Do.
25a		do	865	18.4	10.5	Two-bucket rig	Do.[b]
27		do	865	26.0	18.3	Windlass rig	Rock bottom; fails.
28		Slope	740	20.2	13.4	([c])	Abandoned.
29		do	560	16.0	11.6	Deep-well pump	
30		do	590	25.8	14.6	Two-bucket rig	Fails.
31		Hilltop	625	20.0	8.3	do	Unfailing.
32		Slope	580	13.8	4.7	Chain pump	Do.
32a		do	585	19.3	14.0	do	Do.[d]
33		do	590	22.0	13.4	Windlass rig and house pump.	Fails.
34		do	550	18.9	13.0	Windlass rig and gasoline engine.	Unfailing.
35		do	625	20.3	10.1	Chain pump	Fails.
37		do	635	21.4	9.6	Windlass rig	Unfailing.
38		do	670	16.5	8.9	Two-bucket rig	Do.
39		do	700	21.6	14.4	Chain pump	Do.
41		Plain	250	24.0	8.0		2-inch driven well.
42		Slope	400	25.4	20.4	Windlass rig	Fails.
43		do	440	17.3	10.8	Two-bucket rig	Do.
45		do	460	30.1	26.3	Windlass rig	Do.
47		do	650	15.0	5.5	Two-bucket rig	Unfailing.
49		Hilltop	775	18.5	12.2		Do.
50		do	785	25.1	20.9	Chain pump	Fails.
51		Slope	770	20.0	15.0		Abandoned.
53		do	860	27.9	11.5	Two-bucket rig	Unfailing.
54		do	880	16.7	8.0	do	Do.
56		do	695	15.8	7.5	Wheel and axle rig	Do.
56a		do	705	9.0	3.0	([c])	Fails.[e]
56b		do	685	10.4	3.7	([c])	Unfailing.[f]
57		do	740	29.7	23.3	Two-bucket rig	
58		do	620	16.0	12.8		
59		do	710	14.6	7.3	Chain pump	Fails.
60		do	750	13.8	8.	House pump	Do.
61		do	700	12.2	9.0	Two-bucket rig	Do.
62		do	655	22.2	13.9	Winlass rig	15 feet in rock; fails.
63		do	600	22.1	12.5	Two-bucket rig	
64		do	615	22.8	15.1	do	Unfailing.
65		do	615	16.4	13.3	Chain pump	Do.
66		do	680	19.4	12.3	Windlass rig	
67		do	670	15.0	9.3	Two-bucket rig	
68		do	695	20.6	18.5	do	Do.
69		do	710	21.7	7.9	do	Do.
70		Hilltop	725	30.2	22.4	do	Fails.
71		Slope	690	12.8	7.6	do	
72		do	660	14.4	5.4	do	
73		do	605	27.0	19.5		Abandoned.
76		do	615	21.3	14.8	Two-bucket rig	Unfailing.

[a] 200 south of well No. 22.
[b] 150 feet north of well No. 25.
[c] No rig.
[d] 150 feet south of well No. 32. Strong flow.
[e] 150 feet west of well No. 56.
[f] 200 feet east of well No. 56.

Dug wells ending in stratified drift in Prospect.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
44	....	Slope...	460	26.1	15.6	Deep-well pump....	Unfailing.
74	Charles Kubic...	Plain...	595	18.6	9.8	Windlass and pulley rig and force pump.	Unfailing; for assay see p. 191.
75	....	...do....	595	15.6	10.1	Windlass...........	Fails.
77	....	...do....	595	21.7	18.2	Windlass and pulley rig.	Unfailing.

Drilled wells in Prospect.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
25	Grange Hall....	Plateau.	865	72	1	6	Low.	Schist...	Can be drawn dry temporarily.
26	Parsonage......	...do....	860	60	....	6	....	...do....	For assay see p. 191.
48	F. M. Hufnagle.	Slope...	770	50	11	8	7	(a)	For analysis see p. 191.

[a] Said to have been drilled in trap rock. It seems probable that this is really an amphibolite lens in the Waterbury gneiss, which would have a similar behavior under the drill.

Springs in Prospect.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*°F.*	*Gallons.*	
4	....	Slope.........	625	52	1	Piped to horse trough; unfailing.
6	East Mountain Spring Water Co.	.....do........	730	47	4	Unfailing; cement bottling house.
36	A. D. Field............	.....do........	530	44	6	Gravity rig; unfailing.
40	....	Plain.........	240	47	....	In cellar.
46	T. A. Chatfield.........	Valley........	470	47	....	Masonry basin; unfailing; for assay see p. 191.
52	Clarke.................	Slope.........	715	45	3 or 4	Gravity rig; unfailing.
55	....	.....do........	770	45	Abundant.	Do.

QUALITY OF GROUND WATER.

Below are given the results of two analyses and three assays of samples of ground water collected in Prospect. The waters are of the calcium-carbonate type, low in mineral content, and suitable for general use. All are soft except No. 11, and it is by no means a hard water. They will deposit little scale and are otherwise apparently acceptable for use in boilers, although there is some possibility that they may corrode the boilers, their action depending upon the conditions occurring in actual practice.

Chemical composition and classification of ground waters in Prospect.

[Parts per million; collected Nov. 12, 1915; analyst, S. C. Dinsmore. Numbers at heads of columns refer to corresponding well numbers on Pl. III; see also records corresponding in number, pp. 188–190.]

	Analyses.[a]		Assays.[b]		
	11	48[c]	26	46	74
Silica (SiO_2)	10	13			
Iron (Fe)	.05	.05	Trace.	Trace.	Trace.
Calcium (Ca)	14	8.5			
Magnesium (Mg)	5.9	2.0			
Sodium and potassium (Na+K)[d]	6.3	Trace.	4	3	7
Carbonate radicle (CO_3)	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	49	24	38	29	32
Sulphate radicle (SO_4)	14	.0	15	3	Trace.
Chloride radicle (Cl)	10	4.0	7	4	11
Nitrate radicle (NO_3)	5.0	1.7			
Total dissolved solids	96	47	[d] 81	[d] 51	[d] 60
Total hardness as $CaCO_3$	[d] 59	[d] 29	48	26	27
Scale-forming constituents[d]	61	41	65	40	40
Foaming constituents[d]	17	Trace.	10	10	20
Chemical character	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion[e]	(?)	(?)	(?)	(?)	(?)
Quality for boiler use	Good.	Good.	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Collected Nov. 11, 1915.
[d] Computed.
[e] Based on computed value; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

Prospect has no public water supply, but several of its drainage basins supply other towns. In the northwest corner of the town on tributaries of Beaverpond Brook there are two reservoirs belonging to the Waterbury system. Near the middle of the south boundary there is a 110,000,000-gallon reservoir which is part of the Naugatuck system. In the northeast corner, on the headwaters of Tenmile River, the New Haven Water Co. has a reservoir from which water is supplied to Cheshire, the various villages in Hamden, and some of the higher parts of the city of New Haven.

SIMSBURY.

AREA, POPULATION, AND INDUSTRIES.

Simsbury is a lowland town a little northwest of the center of Hartford County. It contains three villages—Simsbury, near the center; Weatogue, 2 miles south; and Tariffville, in the northeast corner. Hoskins, between Simsbury and Tariffville, and West Simsbury are smaller settlements. There are post offices and stores at all these places except Hoskins. The Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad runs north and south through the town and has stations at Simsbury and Weatogue. The Central New England Railway runs in a general northeasterly direction through the town and has stations at Tariffville and Simsbury,

the latter used jointly with the Northampton division, and also flag stations at Hoskins and Stratton Brook. From Tariffville a branch of the Central New England Railway runs northward to Springfield, Mass. Stages run between Stratton Brook and West Simsbury and between Tariffville and the settlements in Granby.

The area of Simsbury is about 31 square miles, of which 55 per cent is wooded. The woodlands are well distributed except for a cleared belt a mile wide along Farmington River and the neighborhood of West Simsbury. In the lowlands there are extensive stands of white pine (*Pinus strobus*) similar to those in Granby. (See Pl. VI, *B*.) There are about 66 miles of roads worked by the town, in part of macadam and in part of dirt construction. In addition there are 9 miles of State trunk-line roads of bituminous macadam. The trunk line connecting Farmington and Granby runs through Weatogue, Simsbury, and Hoskins and is joined by a feeder from West Hartford at Weatogue.

Simsbury was settled and incorporated in 1670 and then included the present territory of Canton and Granby and part of East Granby. Granby and the part of East Granby were taken away in 1786 and Canton in 1806. The population in 1910 was 2,537. The table below shows that since the separation of Canton in 1806 the population has increased in general, but that the periods from 1830 to 1840 and from 1850 to 1880 show losses. The gain since 1880 has been due in part to the growth of the safety-fuse industry, in part to the cultivation of wrapper and binder tobacco, and in part to the development of country residences.

Population of Simsbury, 1756 to 1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1756	2,275	1820	1,954	1880	1,830
1774	3,700	1830	2,221	1890	1,874
1782	4,664	1840	1,895	1900	2,094
1790	2,576	1850	2,737	1910	2,537
1800	2,952	1860	2,410		
1810	1,966	1870	2,051		

[a] Connecticut Register and Manual, 1915, p. 655.

The principal industries of Simsbury are agriculture, chiefly the raising of tobacco, and the manufacture of safety-fuse for igniting explosives.

SURFACE FEATURES.

The topographic elements of Simsbury are a central plain 3½ to 4 miles wide; gently rounded hills that rise 100 to 200 feet above the plain; and two trap ridges, 150 to 700 feet high, bounding the plain on the east and west. The total relief of the town is 840 feet. The

highest point is on the crest of the eastern trap ridge (Talcott Mountain) near the south boundary and is 960 feet above sea level; the lowest point, where Farmington River leaves the town at Tariffville, is only 120 feet above sea level.

The geologic structure of Simsbury is similar to that of Avon and may be understood from the section across that town (fig. 18). The section across Canton (fig. 22) extends a little way into Simsbury and should also be referred to.

During the Triassic period central Connecticut was a broad valley into which were washed vast amounts of sand, clay, and gravel that were ultimately consolidated into sandstone, shale, and conglomerate. The process of deposition was interrupted three times by the quiet eruption of basaltic lava, which upon cooling became the intercalated trap sheets. The second eruption was the greatest and formed the thickest of the sheets. There was also intrusion of lava along a deeply buried horizon which eventually formed the trap sheet that follows much of the western boundary of the lowland. Subsequently the whole region was broken into fault blocks that were tilted to the east. Erosion has cut away the softer sediments, leaving the harder trap exposed as ridges and cliffs. The middle extrusive sheet is known as the "Main" sheet, as it is the thickest and most prominent. The lower and upper sheets are known, respectively, as the "Anterior" and "Posterior" sheets, as they crop out on the cliff or face side and on the back of the ridge formed by the "Main" sheet.

A number of faults forming minor blocks have been identified by Davis.[66] Three of these cut and offset the intrusive sheet in the western part of Simsbury and make gaps in the ridge. One gap is followed by the Central New England Railway and a highway, and another is between the hills locally known as The Hedgehog and The Sugarloaf. Davis recognized eight faults cutting the eastern trap ridges within the limits of Simsbury. All bear west of north, but only two cause conspicuous offsetting of the ridge. One of these is followed by the Weatogue-West Hartford road, and the other conditioned the sag in the trap ridge that determined the eastward turn in the course of Farmington River at Tariffville.

Prior to the glacial epoch the topography of this region was somewhat more rugged than it is now, but the ice ground off many of the projections and plastered débris into the hollows. After the recession of the ice sheet from Simsbury a lake was formed in the depression between the trap ridges. On the north it was dammed by the ice sheet and on the south by a barrier of stratified drift near Plain-

[66] Davis, W. M., The Triassic formation of Connecticut: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, pl. 19, 1898.

ville. The lowest point in the rim of the lake was a shallow sag in the trap ridge at Tariffville, and this became the outlet and was cut down to make a very picturesque gorge.[67] It is probable that Salmon Brook (Granby) flowed northward through the sag in early Tertiary time, but that its flow was diverted to the south through headward erosion and stream capture by a tributary of the Farmington. That the gorge is postglacial and not older is shown by the absence of glacial deposits from its walls and by its sharp, deep cross section. Were it older it would be wider and have gentle slopes, but it is so steep and narrow that there is no room for a road and one had to be blasted out of the rock.

Between the long trap ridges is a rolling plain composed of the débris washed into the glacial lake. In the middle of this valley several hills rise 100 to 200 feet above the plain. These hills stand up presumably because they are underlain by a coarser and more resistant portion of the sandstone, and by virtue of their height they escaped burial by the sediments deposited in and around the lake.

Simsbury is drained by Farmington River and smaller streams tributary to it. The Farmington flows northward past the foot of the west slope of Talcott Mountain. Some figures on the flow of this stream are given in the report on Farmington (p. 121). The principal tributary in Simsbury is Hop Brook, which is joined by Stratton Brook a little west of Simsbury and enters the Farmington near the southern part of the village. Nod Brook, which joins the Farmington in Avon, drains part of southwestern Simsbury, and a branch of Salmon Brook drains the northwest corner. Only short, steep brooks enter Farmington River from the east. The results of several float measurements made in Simsbury are given in the following table:

Float measurements of streams in Simsbury.

Stream.	Location.	Second-feet.	Date.
A south branch of Salmon Brook	Near well No. 24	1.6	Sept. 28, 1915
	⅜ mile north of Weatogue	.5	Sept. 24, 1915
Stratton Brook	¼ mile above mouth	12.5	Sept. 27, 1915
Branch of Nod Brook	Near well No. 56	1.8	July 9, 1915
Do	⅜ mile south of well No. 58	1.9	Do.

WATER-BEARING FORMATIONS.

Sandstone and trap rock.—The attitude, character, and distribution of the bedrocks of Simsbury have been described in the foregoing section. Both the sedimentary rocks and the trap are cut by fissures which, though they may have any position, tend to be par-

[67] Kümmel, H. B., Some rivers of Connecticut: Jour. Geology, vol. 1, pp. 371-393, 1893.

allel or normal to the plane of bedding. Some of the cracks are due to shrinkage through desiccation or cooling, but most of them are the result of the jostling and crushing to which the rocks were subjected during tilting. Water is carried in these fissures and may be recovered by means of drilled wells. The trap sheets are less satisfactory sources of water supply than the sedimentary rocks for two reasons. In the first place, on account of their bold topographic forms the trap sheets do not hold water as well as the less prominent rocks; and in the second place the trap is very hard, so that drilling wells in it is relatively costly.

Some water is probably held in pores in the sandstone and conglomerate, but these rocks do not form an important source of supply. No water-bearing horizon is known to exist in them, and even if they contained zones of suitable texture it is probable that faults would interrupt their continuity so much as to spoil their usefulness.

Only one drilled well was visited in Simsbury, but others have been put down. Many more could be made, for it is highly probable that drilling at any given point would yield satisfactory results within a reasonable distance.

Till.—Till forms a mantle over those parts of Simsbury more than 300 to 340 feet above sea level, except on the flank of Talcott Mountain, where the till extends down to an elevation of about 200 feet. It is a heterogeneous mixture of glacial débris; pebbles and boulders are embedded in a matrix of sand, silt, clay, and rock flour. The till has many fine pores that absorb and slowly transmit water and yield moderate supplies to dug wells. If a well in till is reasonably deep and if it is not on a steep slope, it is likely to be reliable in all seasons. Seven such wells were measured in Simsbury. Three were said never to fail and one was said to fail; the reliability of the other three was not ascertained. The depth to water ranged from 9.5 feet in well No. 13 (see Pl. III) to 23.3 feet in well No. 14 and averaged 14.1 feet.

Stratified drift.—The surface material of the lower parts of Simsbury is stratified drift—that is, the reworked and washed material of the till sorted out and laid down in beds and lenses of different coarseness. It has larger and more freely connecting pores than the till and in general yields more satisfactory supplies. Measurements were made of 45 wells dug in stratified drift in Simsbury. The depth to water in them ranged from 1.6 feet in well No. 38 (see Pl. III) to 23.8 feet in well No. 59 and averaged 11.6 feet. The reliability of all but 10 of these wells was ascertained; 26 were said never to fail and 9 to fail.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Simsbury.

No. on Pl. III.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
		Feet.	*Feet.*	*Feet.*		
4	Plain	300	27.3	22.1	Chain pump	
11	...do	275	21.0	11.8	Windlass	Fails.
13	Slope	320	11.8	9.5	.....do	Do.
14	...do	320	27.1	23.3	Chain pump	Do.
21	...do	350	17.5	9.8	.....do	
22	...do	410	16.7	9.7	.....do	
23	Plain	330	22.3	12.2	.....do	Rock bottom; unfailing.

Dug wells ending in stratified drift in Simsbury.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.				
1		Plain	265	15.5	13.7	Chain pump	Unfailing.
2		Slope	265	16.5	11.9	Windlass rig	Do.
3		Plain	280	16.2	12.7	.....do	
5		...do	305	14.1	6.4	Windlass rig and house pump.	Do.
6	Fred Holcomb	...do	305	19	13	Deep-well pump	Unfailing; for analysis see p. 198.
7		...do	300	14.2	8.3	House pump	Unfailing.
8		...do	305	18.6	12.6	.....do	Fails.
9		...do	305	8	6	Deep-well pump	Unfailing.
10		...do	280	15.8	13.7	.....do	Do.
12		...do	305	24.3	20.2	Windlass and pulley rig.	Do.
15		...do	295	15.9	12.9	Windlass rig	Do.
17		...do	310	14.4	11.2	Two-bucket rig	Do.[a]
18		...do	315	11	9.7		Do.
19		...do	300	12.2	9.7	([b])	
20		...do	300	23.7	12.3	Windlass rig	Do.[c]
24		Slope	195	18.4	15.8	.....do	
26		Plain	280	10.9	7.7	Pitcher pump	Fails.
27		...do	275		21	Deep-well pump	
28		...do	275	19.1	12.2	Chain pump	Do.
29		...do	305	21.5	15	.....do	Unfailing.
30		...do	250	13	11	.....do	Fails.
31		...do	260	11.8	4.8	.....do	Unfailing.
32	M. H. Tuller	...do	250	18.6	15	.....do	Unfailing; for assay see p. 198.
33		...do	260	11.8	4.8	.....do	Do.
34		...do	240	9.3	7.6	.....do	Do.
36		...do	220	11.4	8.3	Windlass rig	
37		Slope	285	14.1	9.7	House pump	
38		Plain	190	7.9	1.6	Chain pump	
39		...do	180	17.2	11.3	.....do	Unfailing.
40		Slope	200	12.8	10.3	Pitcher pump and house pump.	Tiled; unfailing.
41		...do	310	16.8	13.4	Chain pump	Fails.
43		...do	190	14.8	10.5	Two-bucket rig	Unfailing.
44	Town farm	Plain	140	18.8	15.9	Chain pump	Do.
45		Slope	240	12.7	8.5	Windlass rig	Fails.
47		Plain	150	17.5	9.7	Chain pump	
50		Slope	175	18.5	15.4	([b])	Unfailing.
51		...do	180	15.8	12.7		Fails.
52	R. F. Eno	Plain	175	17.3	13.3	Windlass rig	Unfailing.
53		...do	165	12.2	7.4	Chain pump	Do.
55		...do	155	16.8	14.6	.....do	Fails.
56		Slope	305	14.3	11.5	.....do	Unfailing.
58		Plain	280	13.7	9.9	([b])	
59		...do	320	24.8	23.8	([b])	Do.
60		...do	190	17.5	14.5	Chain pump	Fails.
61		...do	150	15			

[a] Water level varies 4 or 5 feet.
[b] No rig.
[c] Dug 4 feet into rock. Part of the water comes from a crack in the rock and part from the stratified drift.

Driven wells in Simsbury.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Diameter.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	
16	T. T. Case	Plain	195	40		3	
49		do	170	15	15	1¼	(a).
57		do	295	21	10½		Pitcher pump; 14-foot pit; unfailing.

a Driven 10 feet below a 5-foot pit. After 5 years' use the screen had to be cleaned of incrusted material.

Drilled well in Simsbury.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*		
25	T. J. Clark, jr.	Plain	260	113	26	6	Sandstone	For analysis see p. 198.

Springs in Simsbury.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*° F.*	*Gallons.*	
35	Mrs. A. E. Woods	Valley	180		10	Unfailing; for assay see p. 198.
42	A. E. & F. C. Hoskins	Plain	260	55		Pumped by windmill; unfailing; for assay see p. 198.
46		Foot of hill	180	50		Piped to house.
48		Swale	180	58		Operates a ram.
54		Foot of slope	180	50		One of a group of springs.

QUALITY OF GROUND WATER.

The results of two analyses and three assays of samples of ground water collected in Simsbury are given below. Two of the waters, Nos. 35 and 42, are moderately mineralized but very soft waters of the sodium-carbonate type and might cause trouble by foaming in boilers; they are therefore classed as bad and fair, respectively, for boiler use. No. 35 will deposit little scale and No. 42 only a moderate amount. The other waters are low in mineral content and are of the calcium-carbonate type; although No. 25 is classified as soft, it contains more hardening ingredients than the others. All the waters are suitable for domestic use.

Chemical composition and classification of ground waters in Simsbury.

[Parts per million; collected Dec. 6, 1915; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding well numbers on Pl. III; see also records corresponding in number, pp. 196–197.]

	Analyses.[a]		Assays.[b]		
	6	25[c]	32	35	42
Silica (SiO_2)	10	18			
Iron (Fe)	Trace.	.50	Trace.	Trace.	0.75
Calcium (Ca)	10	25			
Magnesium (Mg)	1.9	.9			
Sodium and potassium (Na+K)[d]	3.8	[e] 11	2	99	67
Carbonate radicle (CO_3)	.0	.0	0	0	0
Bicarbonate radicle (HCO_3)	34	87	32	273	185
Sulphate radicle (SO_4)	3.3	4.9	0	Trace.	20
Chloride radicle (Cl)	4.0	1.8	12	6	8
Nitrate radicle (NO_3)	5.0	.70			
Total dissolved solids	58	101	[d] 62	[d] 260	[d] 220
Total hardness as $CaCO_3$	[d] 33	[d] 66	40	35	49
Scale-forming constituents[d]	43	93	55	50	65
Foaming constituents[d]	10	30	([f])	270	180
Chemical character	Ca–CO_3	Ca–CO_3	Ca–CO_3	Na–CO_3	Na–CO_3
Probability of corrosion[g]	(?)	N	(?)	N	N
Quality for boiler use	Good.	Good.	Good.	Bad.	Fair.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.

[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Analyzed by Alfred A. Chambers, U. S. Geol. Survey.
[d] Computed.
[e] Determined.
[f] Less than 10 parts per million.
[g] Based on computed value; (?)=corrosion uncertain; N=noncorrosive.

PUBLIC WATER SUPPLIES.

There are three water companies supplying customers in the town of Simsbury.

The Simsbury Water Co. began as a small communal system in 1874 but has never become extensive. The original subscribers each got a right to a ¾-inch service connection except the New York, New Haven & Hartford Railroad Co., which got a right to a 1¼-inch connection. Water is deflected from Grimes Brook, a mile west of the village, and is carried in a short ditch to a basin, where it enters the main. The company owns but does not use a small reservoir on the same brook. Water is distributed under a low pressure through 2 miles of mains to about 100 customers. Mr. Horace Belden, president, estimates the average daily consumption at 75,000 gallons, of which a large part is used by the railroad and the fuse factory.

The Village Water Co., of Simsbury, was organized to provide fire protection and began operations in 1903. A stone dam 8 to 10 feet high on Stratton Brook south of West Simsbury forms a 4,000,000-gallon reservoir from which water is delivered by gravity through 8 miles of mains to 51 fire hydrants and 254 service taps. The pressure ranges from 48 to 60 pounds to the square inch. The average daily consumption is estimated at 68,800 gallons. The company owns a second reservoir lower down on Stratton Brook, but it is not used as it does not give sufficient head.

The Westover Plain Water Co. is a small concern supplying 13 customers in West Simsbury from an inclosed spring west of the village. The water is delivered by gravity through about 1 mile of main pipe.

SOUTHINGTON.

AREA, POPULATION, AND INDUSTRIES.

Southington is in the southwest corner of Hartford County. It includes two large settlements, Southington and Plantsville, and two smaller ones, Milldale and Marion. At each of these there are stores and post offices. The Northampton division (Canal Road) of the New York, New Haven & Hartford Railroad has stations at Southington, Plantsville, and Milldale. Electric trolley lines connect the town with Waterbury, New Haven, Meriden, Plainville, New Britain, and Hartford.

The area of Southington is about 40 square miles, of which one-fourth is woodland. Macadam and bituminous-macadam State trunk-line roads connect Southington with Plainville, Meriden, Cheshire, Waterbury, and more distant points. The town roads are in general good, but some that cross the sand plains are poor. There are about 100 miles of town roads and 11 miles of State roads.

In 1779 this territory was taken from Farmington and incorporated under its present name. Since then it has suffered no change of territory, except the separation of part of Wolcott in 1796. In 1889 the borough of Southington, comprising Southington and Plantsville, was incorporated. The population of the town in 1920 was 8,440, of which the borough contained 5,085.

Population of Southington, 1782 to 1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1782	1,882	1830	1,844	1880	5,411
1790	2,110	1840	1,887	1890	5,501
1800	1,804	1850	2,135	1900	5,890
1810	1,807	1860	3,315	1910	6,516
1820	1,875	1870	4,314		

[a] Connecticut Register and Manual, 1915, p. 655.

Until 1840 the population remained about stationary. Since then there has been a fairly uniform growth, which will probably continue, as the town is advantageously situated for manufacturing.

The principal industries of Southington are agriculture, comprising chiefly truck farming and dairying, and the manufacture of hardware, particularly edge tools, bolts, screws, and builder's hardware. Some brick are made in the Marion district.

SURFACE FEATURES.

Most of Southington is a relatively flat plain 180 to 220 feet above sea level, below which the streams have cut valleys. On the east side of the plain is a steep ridge with a westward-facing cliff formed by the trap sheet of the Meriden West Peak range. The highest point in the town is on this ridge at the south boundary and is 905 feet above sea level. The lowest point in the town is where Quinnipiac River crosses into Meriden, about 100 feet above sea level. The peaks of the West Peak range are for the most part 500 to 754 feet in elevation and are separated by gaps 200 to 400 feet deep. Below West Peak, to the south and west, is a shelf or terrace that forms a striking topographic feature visible for many miles to the north and northwest. The eminence of West Peak is due to the fact that the thick "Main" sheet of trap resists erosion better than the associated sandstones and shales. The thinner "Anterior" sheet, which underlies the "Main" sheet and is separated from it by several hundred feet of sandstone and shale, is

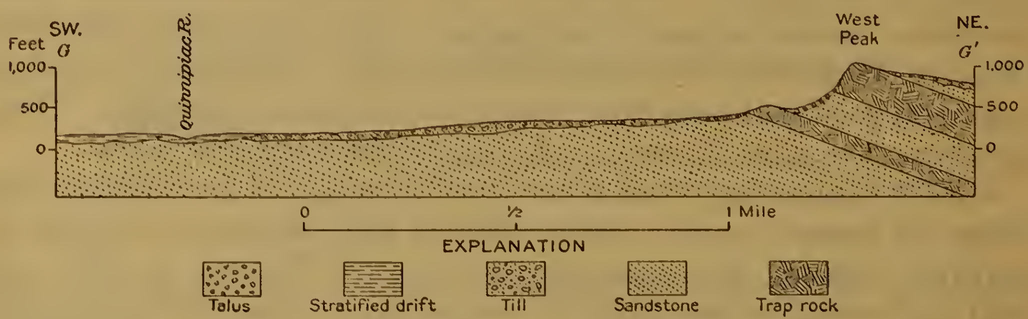


FIGURE 29.—Section through Meriden West Peak.

less able to withstand erosion, so that it has less effect on the topography and makes a bench below the principal cliff. This relation of the topography to the "Main" and "Anterior" sheets is shown in figure 29, which is a section along the line *G–G'*, Plate II.

At the western edge of the Southington plain is the steep and high front of the western highland plateau, locally called Wolcott Mountain, Southington Mountain, or Compounce Mountain. For most of its extent the scarp, which is 500 to 700 feet above sea level, is formed by the very resistant Hoosac schist, but the lower slopes of the southern portion are of the Prospect porphyritic granite gneiss.

Near the middle of the valley in the northern part of Southington two smaller hills rise above the sand plain to heights of 300 and 320 feet above sea level. They have gentle slopes and rather broad, flat crests, and are elongated on the north and south axes. They have cores of shale and sandstone covered by a mantle of till 10 to 30 feet thick. Prior to the glacial epoch their general shape was no doubt the same as at present, but the detail was rougher. The ice sheet passing over them polished down some of the projections and filled in the depressions with till, thus forming "rock drumlins." Figure 30 shows these relations and is a section along the line *F–F'*, Plate II.

The Southington plain is a glacial outwash plain composed of stratified drift—the sand and gravel washed out from the retreating glacier by streams of melt water. East of Southington and Plantsville there are a number of kettle holes—depressions 15 to 35 feet deep and 100 to 500 feet across in the level surface of the plain. As the ice receded fragments broke off, and some of the larger ones stranded and became more or less completely buried in the sands and gravels washed in around them. Upon melting they left these depressions. Most of the kettle holes of Southington are somewhat wet and swampy, and in some there are small ponds during much of the year.

Compounce Pond, in the northwest corner of the town, is of unusual origin. Its west bank is formed by the slope of Compounce Mountain, the front of the western highland, and its east bank is an esker about a mile long. The north end of the esker, which is about a quarter of a

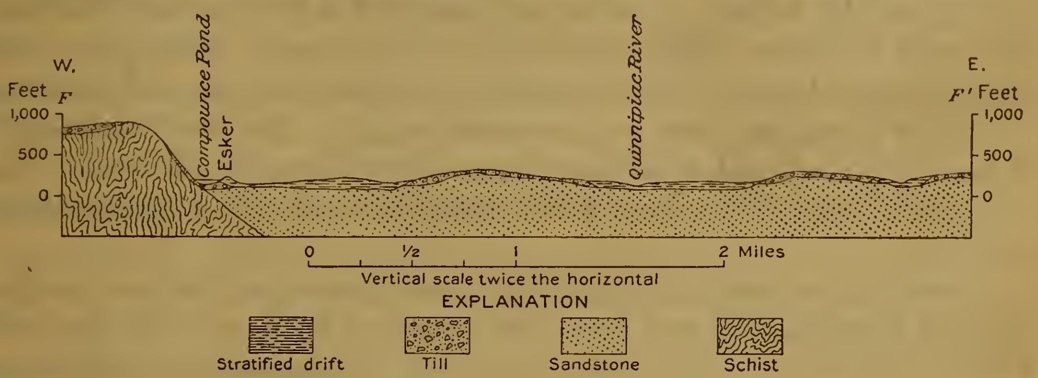


FIGURE 30.—Section across Southington.

mile north of the head of the lake, lies close against the foot of Compounce Mountain and is 20 to 30 feet high and narrow crested. Farther south it is broader and about 35 feet higher and swings away from the mountain a quarter of a mile. Opposite the south end of the pond the coarse washed and sorted material composing the esker is exposed in a trolley cut. A few hundred feet south of the south end of the pond the esker swings back westward toward the foot of the mountain, its width increases, and its height decreases. Immediately after the recession of the ice from the basin the water body must have been somewhat larger, but its outlet soon cut its channel down through the esker to about its present level. At the north end of the lake a delta plain several hundred feet long fills the space between the esker and the foot of the mountain. This delta is composed of the materials that have been washed in from the north and northwest.

Southington is entirely in the drainage basin of Quinnipiac River, which flows from north to south through the town. Patton and Misery brooks, which, in April, 1915, were estimated to flow 5 and 6 second-feet, respectively, enter the Quinnipiac from the east; Eightmile and Tenmile rivers are larger tributaries coming from the west. Eightmile River receives the outlet stream of Compounce Pond.

WATER-BEARING FORMATIONS.

Underlying the surface materials in Southington there are four varieties of bedrock, red sandstone and shale of Triassic age, trap rock, also Triassic, the Hoosac schist, and the Prospect porphyritic granite gneiss.[68]

Schist and gneiss.—The area underlain by the granite gneiss and Hoosac schist includes the steep slope along the west edge of the town. On such a slope the bedrocks are very poorly situated for carrying water. They form a relatively impervious layer and force the water out of the drift in numerous springs and seeps.

Trap rock.—Trap rock underlies the surface materials in a narrow belt along the east boundary of Southington. The edge of the "Main" trap sheet barely crosses the line; the "Anterior" sheet extends a little farther. At the south edge of the town, near Milldale, the basal intrusive trap crops out in a few places. The joints and fissures of the trap rock carry small quantities of water, but nowhere in the town are they used as a source of supply. On the bench south of West Peak several wells have been drilled through the trap of the "Anterior" sheet but draw water from the underlying sedimentary rocks.

Sandstone and shale.—The Triassic sandstones and shales underlie most of Southington and form the source of supply of all the rock wells of the town. The water is probably drawn solely from fissures and not at all from pores in the rock. Mr. Upson's dug well, on West Street (No. 97, Pl. III), is of this type. A description of this well, together with a study of its yield of water, is given on page 47. Thirteen drilled wells ending in sandstone in Southington range in depth from 45 to 198 feet and average 94 feet. Reports obtained for six of these show a range in yield from 1½ to 20 gallons a minute and an average of 12 gallons a minute.

Till.—Till forms the mantle rock in the higher portions of Southington. In the southern part of the town the boundary between the till and the stratified drift is about 160 feet above sea level; in the northern part it is higher, and at the Plainville line it is about 220 feet. The comparatively uniform altitude of this boundary is not fortuitous but was determined by the height and gradient of the streams of melt water that deposited the stratified drift. The grade of the boundary is such that it drops 60 feet in crossing the town and is about the same as the grade of the Quinnipiac, which now drops 50 feet in the same distance.

Two till-covered rock drumlins occupy the divide between Eightmile and Quinnipiac rivers; a third lies between Quinnipiac River and Patton Brook, in the northeast corner of the town; and a

[68] Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 7, 1907.

fourth very low one lies centrally between Plantsville, Milldale, and Marion. Other till-covered areas are the slopes of the east and west sides of the valley. Within these areas dug wells of reasonable depth yield moderately abundant supplies of water and are reliable in dry seasons except where they reach rock or are on very steep slopes. Twenty-five such wells were measured in Southington. The depth to water in them ranged from 4 feet in well No. 28 (see Pl. III) to 24 feet in well No. 75 and averaged 14.2 feet. Of these wells 11 were said never to fail and 8 were said to fail; the reliability of the other 6 wells was not ascertained.

Stratified drift.—The stratified drift is well sorted and washed, so that it is porous and capable of holding and transmitting much water. Wells on the plain which extend a short distance below the water level are sure of an abundant and permanent supply. Mr. Perry's well (No. 11, Pl. III) obtained water in gravel at a depth of 45 feet, and Mr. Krumm's well (No. 70) at a depth of 40 feet. Several dug wells between Southington and Plantsville pass through 45 feet of stratified drift, but the maximum depth may be much greater. (See Plainville report, p. 170.) Measurements were made of 47 wells dug in stratified drift in Southington. The depth to water in them ranged from 4 feet in wells Nos. 25 and 80 to 45 feet in wells Nos. 41 and 42 and averaged 16.1 feet. Of these wells 27 were said to be nonfailing and 5 were said to fail; the reliability of the remaining 15 wells was not ascertained.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Southington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
3	....	Hillside.	330	....	21.9	....	A new well.
4	....	...do....	385	29.5	15.9	Windlass............	Unfailing.
5	....	...do....	380	23.8	11.8	Two-bucket rig.....	Do.
6	....	...do....	270	24.7	20.6	Chain pump.........	Do.
7	....	...do....	285	31.8	19.8	....	Fails.
8	....	...do....	410	22.4	16.7	Chain pump.........	Unfailing.
9	....	...do....	440	35.5	23.3	....	Rock bottom.
13	....	...do....	285	17.5	10.4	Pump in house.....	Fails.
14	....	Hilltop..	295	28.5	21.0	....	8 feet to rock.
19	....	...do....	215	32.7	18.2	Two-bucket rig.....	Unfailing.
21	....	Hillside.	220	20.2	17.1	....	
27	....	Slope...	210	11.6	5.5	Two-bucket rig.....	
28	....	Hilltop..	305	12.2	4.0	Chain pump.........	Abandoned; fails.
51	L. J. Whitehead.	Slope...	255	16.4	9.5	.....do..............	Fails; 2 feet into rock.
53	....	...do....	235	18.5	12.4	Windlass............	Fails; 6 feet into rock.
60	....	Hilltop..	202	19.7	4.8	Two-bucket rig.....	Unfailing.
62	....	Slope...	160	11.0	4.7	Chain pump.........	Do.
75	....	...do....	205	....	24.0	Pitcher pump.......	Reaches rock; fails.
76	....	...do....	280	22.3	16.0	....	Abandoned.
77	....	...do....	220	23.0	13.0	....	Dug to rock; unfailing.
78	....	Plain...	205	15.4	12.9	Pump in house.....	Unfailing.
86	Edw. Wassong...	Slope...	330	31.0	13.5	Deep-well pump....	Do.
87	.....do..........	...do....	390	29.0	16.0	Gravity flow........	Unfailing; for assay see p. 206.
90	....	Ridge...	305	13.1	7.1	Two-bucket rig.....	Reaches rock; fails.
92	....	Plain...	140	21.9	17.9	.....do..............	Fails.

Dug wells ending in stratified drift in Southington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
2		Plain	196	12.2	10.2	Sweep rig and pump in house.	Unfailing.
12		do	200	19.4	11.0	Windlass rig	Fails.
23		do	150	18.5	15.3	Pump in house	Unfailing.
24		Slope	222	40.3	37.3	Two-bucket rig	Fails.
25		Hilltop.	245	33.5	27.8	do	
26		Ridge	220	17.5	13.5		Unfailing.
29		Plain	130	17.3	15.7	Chain pump	
30		Slope	175	22.0	20.4		
31		do	193	19.8	17.3		
32		do	187	15.2	12.3		
33		do	200	22.1	19.2		
34		Plain	222	26.7	23.1		
35		do	222	26.2	23.6	Chain pump	
37		do	165	15.4	10.2	Two-bucket rig	Do.
38		do	185	19.5	16.4	do	Do.
39		do	138	16.4	13.8	Pitcher pump	Abandoned.
40		Slope	160	18.6	13.6	Two-bucket rig	Unfailing.
41	Henry Ludecke	Plain	202	47.0	45.0	do	Tiled.
42	Hartson	do	202	46.1	45.0	do	Tiled; unfailing; abandoned.
43		do	220	53.7	44.4	do	Two tiles at bottom; steady ;abandoned.
44		do	195	31.1	23.0	Deep-well pump	Unfailing; tiled at bottom.
45		Slope	200	11.0	7.8	Chain pump	Unfailing.
46		Plain	185	22.7	16.9	Two-bucket rig and pump in house.	Do.
47		do	180	13.8	10.9	Pump in house	
49	Chas. Stewart	Slope	185	16.3	9.8	Pitcher pump	Fails.
50	F. P. Gridley	Ridge crest.	165	26.4	24.0	Two-bucket rig	Do.
54		Slope	180	19.9	10.9	do	Unfailing.
55		do	200	19.0	8.9	Chain pump	
56		Plain	180	13.5	5.7	do	Do.
57		do	185	23.0	21.6	Two-bucket rig	Do.
63		do	142	12.5	8.0	Pump in house	Do.
64		do	145	15.6	12.1		Tiled; unfailing.
65		do	135	12.9	7.1	Two-bucket rig	Do.
66		do	160		18.0	do	Do.
67		do	150	16.0	12.0	Two-bucket rig and house pump.	Do.
68		do	142	14.2	8.0	Two-bucket rig	Do.
69		do	140	16.7	9.7	Chain pump	Abandoned.
71	H. A. Andrews	Slope	186	17.0	14.0	Pitcher pump	Tiled; unfailing; for assay see p. 206.
72		do	190	13.5	6.8	Two-bucket rig	Unfailing.
73		Plain	155	15.7	13.6	do	Do.
80	Henry Wolff	do	145	7.0	4.0		
83	John Paul	Slope	160	20.1	11.4	Two-bucket rig	Unfailing; for assay see p. 206.
93	Sam'l B. Hill	Plain	130	18.4	12.0	do	Tiled; unfailing.[a]
94		Slope	120	18.2	11.3	Two-bucket rig and pump in house.	Unfailing.
95		Plain	118	13.7	8.0	Chain pump	
96		Slope	115	14.3	8.3	Two-bucket rig and two pumps in house.	Do.
97	Fred Upson	Hilltop	225	22.3	16.8	Two-bucket rig and air-pressure system.	Unfailing; 9 feet in rock; for pumping test and analysis see pp. 47, 206.

[a] Formerly only 16 feet deep, then deepened to 22 feet through quicksand and tiled. The sand has filled in about 3½ feet.

Driven wells in Southington.

No. on Pl. III.	Topographic position.	Elevation above sea level.	Depth of well.	Remarks.
		Feet.	*Feet.*	
1	Plain	225	18	
91	do	145	28	Good, continuous supply.

Drilled wells in Southington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Depth to water.	Diameter.	Yield per minute.	Water-bearing formation.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Inches.*	*Gallons.*	
10	New Britain Water Commission.	Flat hill.	400	91	84	....	....	....	Sandstone.
11	L. Perry........	Swale...	215	45	....	19	6	20	(a).
15	School board...	Hilltop..	305	140	16	20	6	20	Sandstone.
16	Bagi............	Slope....	270	97	8	15 or 16	6	1½ or 2	Do.
17	....	...do.....	260	77	8 or 10	12	6	Good.	Do.
18	Mike Bashkow .	...do.....	250	45	12	10 or 12	6	Fair.	Do.
20	....	...do.....	250	198	16	*b*16	6	7	Do.
22	Joe Massolots...	...do.....	150	91	16	19	....	....	Do.
36	E. R. Dunn....	Plain....	260	90	16	....	....	(c)	Do.
70	John Krumm...	...do.....	160	40	40 (?)	25	6	....	For assay see p. 206.
81	Henry Wolff....	...do.....	145	75	29	....	6	(d)	Sandstone.
84	Geo. Knipfer....	Slope....	245	63	15	(e)	....	....	Do.
85	Elmer Talmadge	...do.....	255	108	....	25	....	....	Do.
88	D'Agostino.....	Hillside.	400	80	*f* 6	....	8	3½	Shale.
89	A. W. Slater....	...do.....	400	60	....	....	6	20	Sandstone; for assay see p. 206.

a Water enters from a gravel bed at the bottom of the well. The following is the section:

	Feet.
Sand and gravel	27
Quicksand	5
Hardpan	4
Coarse sand, White sand	8
Gravel with water	1

b Sometimes overflows in spring thaws.
c A fissure at depth of 50 feet yields 5 gallons a minute; a second fissure at 90 feet increases the yield to 24 gallons a minute.
d Use a 2-horsepower gasoline engine.
e Air-pressure tank.
f Through about 6 feet of till, 10 feet of trap, and 64 feet of sandstone.

Springs in Southington.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	° *F.*	*Gallons.*	
48	Charles Stewart....	Foot of slope..	200	....	10-15	Unfailing.
52	....	Slope..........	485	46	2	Supplies horse trough.
58	J. G. Raymond....	Foot of terrace.	160	45	Good.	Unfailing; for analysis see p. 206.
59	Jacob Miller........	.....do..........	170	....	10	Unfailing; "Wonx Spring."
61	....	Slope..........	180	46	Good.	Unfailing.
74	....	.....do..........	145	....	Very big.	At roadside.
79	....	Swale..........	200	....	1	
82	....	Slope..........	140	47	....	

QUALITY OF GROUND WATER.

The results of two analyses and five assays of samples of ground water collected in Southington are given in the subjoined table. With the exception of Nos. 58 and 71 the waters are of the calcium-carbonate type. No. 58 is calcium-nitrate in chemical character, and No. 71 is a sodium-carbonate water. All the waters are low in mineral content except No. 97, which is classed as moderate; none of them are hard. No. 97 contains the largest amount of hardening

constituents. Although the waters are classed as good for domestic use, the high nitrate in Nos. 58 and 97 indicates possible pollution. On account of their content of scale-forming constituents, Nos. 97 and 87 are classified as fair for boiler use; the other waters are considered good. Corrosion will not occur when Nos. 71, 83, and 89 are employed for steaming purposes, but the probability of corrosion is doubtful in the other waters.

Chemical composition and classification of ground waters in Southington.

[Parts per million; S. C. Dinsmore, analyst. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 203-205.]

	Analyses.[a]		Assays.[b]				
	58	97 [c]	70	71	83	87	89
Silica (SiO_2)	9.5	15					
Iron (Fe)	.05	.65	Trace.	Trace.	Trace.	0.20	0.20
Calcium (Ca)	17	36					
Magnesium (Mg)	3.7	1.4					
Sodium and potassium (Na+K) [d]	6.7	[e] 18	3	26	18	4	25
Carbonate radicle (CO_3)	.0	.0	0	0	0	0	0
Bicarbonate radicle (HCO_3)	20	105	56	78	114	105	144
Sulphate radicle (SO_4)	5.7	20	5	5	5	5	3
Chloride radicle (Cl)	8.0	7.4	11	27	8	4	4
Nitrate radicle (NO_3)	48	12					
Total dissolved solids	110	162	[d] 88	[d] 130	[d] 130	[d] 120	[d] 150
Total hardness as $CaCO_3$	[d] 58	[d] 96	60	56	73	90	77
Scale-forming constituents [d]	66	120	75	70	90	100	90
Foaming constituents [d]	18	49	10	70	50	10	70
Chemical character	Ca-NO_3	Ca-CO_3	Ca-CO_3	Na-CO_3	Ca-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion [f]	(?)	(?)	(?)	N	N	(?)	N
Quality for boiler use	Good.	Fair.	Good.	Good.	Good.	Fair.	Good.
Quality for domestic use	Good.	Good.	Good.	Good.	Good.	Good.	Good.
Date of collection (1915)	Nov. 11	Dec. 10	Nov. 10	Nov. 10	Nov. 11	Nov. 11	Nov. 11

[a] For methods used in analyses and accuracy of results, see pp. 59-61.
[b] Approximations; for methods used and reliability of results, see pp. 59-61.
[c] Analyzed by Alfred A. Chambers, U. S. Geol. Survey.
[d] Computed.
[e] Determined.
[f] Based on computed value; (?)=corrosion uncertain; N=noncorrosive.

PUBLIC WATER SUPPLIES.

Southington, Plantsville, and Marion are supplied with water by the works of the Southington Waterworks Commission. In 1882 the Southington Water Co., a private concern, was incorporated, one-fourth of its capital stock being subscribed by the town of Southington. Reservoirs and pipe lines were built, and in 1884 operations were begun. In 1911 the town bought out the company for $234,292.25. There are four reservoirs on Falls Brook in the southeast corner of Wolcott, three of which are impounding reservoirs and the fourth a distributing reservoir, with a capacity of 2,373,000 gallons. The water is distributed by gravity under a pressure of 80 to 90 pounds to the square inch through 31 miles of mains to 1,102 service taps and 152 fire hydrants.

In the northeast corner of the town is Crescent Pond, a spring-fed reservoir of the Plainville Water Co. (See Plainville report, p. 176.)

A mile southeast of it is the Shuttle Meadow reservoir of the New Britain Water Commission. (See New Britain report, p. 157.)

Most of the possible reservoir sites and collecting basins near Southington have been taken up and developed. If Southington grows much larger it may be necessary to develop the ground waters of the town. At several places batteries of wells would yield abundant supplies. Lines of wells across the valley of Eightmile River northwest of Southington village, or across the flat valley of Patton Brook in the northeast corner of the town, would probably give satisfactory results. It is possible that pollution from the Bristol sewage-disposal plant might make water from the valley of Eightmile River unsuitable, and careful sanitary studies should be made before developing this supply.

WOLCOTT.

AREA, POPULATION, AND INDUSTRIES.

Wolcott is a small highland town near the middle of the north tier of towns of New Haven County, south of Bristol and northeast of Waterbury. The principal settlement is the "Center," but there is also a small settlement locally known as Woodtick, a mile and a half south of the center, and a summer colony at the Waterbury reservoir, in the southeast corner of the town. There is no post office, but the town is served by rural delivery. Railroad connection is available only at points in towns near by. The line of the Waterbury & Milldale Tramway Co. follows the south boundary.

Wolcott has an area of 21 square miles, of which two-thirds is woodland. There are about 48 miles of roads, which are in general well kept and are good, though hilly in sections. The State trunk-line highway connecting Waterbury and Meriden runs along the south boundary.

The territory of Wolcott was taken from Waterbury and Southington and incorporated as a separate town in 1796. From 1790 to 1840 the Center was a very busy place and was known as Farmingbury. Its prosperity depended on the abundant agricultural products and on an extensive freighting business between the growing manufacturing towns of the Naugatuck Valley and the wagon freight routes from Milldale to Hartford, Middletown, and New Haven. During the period that the Farmington canal was in use (1827 to 1847) much of Waterbury's raw materials and manufactured products passed through Wolcott.[69] The development of railroads altered these conditions: many farm products could be brought from the West to economic advantage, and the long wagon haul through Wolcott was eliminated. There have been desultory attempts at manufacturing but the attraction of the larger towns near by has

[69] Orcutt, Samuel, History of Wolcott.

continually tended to reduce the population. From 1880 on, as shown in the table below, the population increased a little, presumably on account of the building of suburban residences along the south boundary of the town and in the valley of Mad River. The population in 1910 was 563, about three-fifths as great as in 1810.

Population of Wolcott, 1800–1910.[a]

Year.	Population.	Year.	Population.	Year.	Population.
1800	948	1840	633	1880	493
1810	952	1850	603	1890	522
1820	943	1860	574	1900	581
1830	843	1870	491	1910	563

[a] Connecticut Register and Manual, 1915, p. 656.

The principal industry of Wolcott is agriculture, but a good deal of cordwood and charcoal is produced for use in the brass foundries of the Naugatuck Valley.

SURFACE FEATURES.

Wolcott is an uplifted and well-dissected plateau. The total range of elevation is 585 feet. The lowest point is where Mad River crosses the southwest boundary, at 435 feet above sea level, and the highest point is Spindle Hill, with an elevation of 1,020 feet. In its former undissected condition the plateau had an average elevation of 900 feet, but the north edge was slightly higher and the south edge slightly lower. On it were a few residual hills 100 to 150 feet high. The surface of the plateau is believed to be part of one of a series of wave-cut terraces that extend across Connecticut but are marked only by the general accordance of altitude of flat hilltops. The terrace has been elevated and partly destroyed by subsequent weathering and erosion. The parts of the terrace more distant from major streams have suffered less than the parts nearer the streams. This probably accounts for the rather flat topography north of Spindle Hill and for the more rugged, valley-cut region in the southwest corner of the town.

A mile northwest of the center, at a sawmill on Mad River, there are several excellent potholes in a gneiss ledge, which makes a natural dam on which the sawmill is built. The best is about 8 feet in diameter and is said to have been 40 feet deep, but it is now so filled with rubbish that it is only 15 feet deep. There are also several partial potholes in the ledge. The potholes were formed by eddies in the rapid current that caught up pebbles and swirled them around so that they bored out the cavities.

Wolcott is drained for the most part by Mad River and its tributaries. Mad River rises just north of the Bristol town line, flows

southward past the middle of Wolcott, and then turns southwestward through Woodtick into Waterbury and so reaches Naugatuck River. About a square mile in the northwest corner is drained to Hancock Brook in Plymouth, and 5 square miles along the eastern boundary to Quinnipiac River in Southington.

WATER-BEARING FORMATIONS.

Two principal varieties of bedrock have been recognized in Wolcott, the Hoosac schist and the Waterbury gneiss.[70] There is a small dike of trap rock in the southeast corner of the town.

Schist and gneiss.—The Hoosac schist, which underlies all of Wolcott except a belt a mile wide along the southwest boundary, is a typical light to dark gray mica schist, composed essentially of mica and quartz, with minor amounts of garnet, staurolite, and feldspar and the decomposition products of all these minerals. This rock was originally a series of clays and clayey sands which became consolidated to form shale and shaly sandstone. These in turn were altered by crushing and mashing accompanied by heat during periods of mountain-building disturbances. The clay was in large part converted to white mica, and the mica flakes were so turned that they are roughly parallel and give the cleavage so characteristic of schists.

The Waterbury gneiss, according to Gregory,[71] is a variety of the Hoosac schist into which so many sheets and dikes of granitic and hornblendic material have been injected that its character is materially altered. Such injections are widely distributed in the schist, but it is only locally that they are so abundant.

The schist and gneiss carry and yield water in essentially the same way. They are very old and have many fissures and cracks. When water falls as rain a part soaks into the soil, and some of this finds its way into the intricate system of interconnecting channels in the bedrock. It is highly probable that a well drilled at any point in the schist or gneiss will intersect one or more water-bearing fissures within a reasonable distance and will obtain a supply of water sufficient for domestic or farm needs. Only one such well has been drilled in Wolcott, but drilling would undoubtedly prove worth while for many of the inhabitants whose present supplies are inadequate or unreliable.

Trap rock.—The State road is crossed near the southeast corner of the town by a trap dike intruded into the Hoosac schist. It lies parallel to the general direction of the schistosity, bearing N. 15° E., is 20 feet thick, and forms a sharp little ridge 5 to 15 feet high and at

[70] Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 7, 1907.

[71] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, p. 100, 1906.

187118°—21—WSP 466——14

least 500 feet long. It is of so slight areal extent that it is negligible as a source of water supply. The trap is probably of Triassic age and related to the trap of the lowland.

Till.—Over the bedrock there is a mantle of glacial till everywhere in Wolcott except for two areas of stratified drift and the many small areas of rock outcrop. The till is a heterogeneous mixture of glacial débris of a great variety of kinds and sizes. Fine rock flour and clay, silt, sand, pebbles, and boulders, plowed up and scraped along by the glacier, were plastered over the bedrock in a sheet that in places is as much as 40 feet thick, though for the most part only 15 or 20 feet. Except on steep slopes from which the water may seep readily or where the till sheet is thin, wells dug in till will in general yield supplies of water sufficient in volume and constancy for domestic and farm needs. Measurements were made of 80 such wells in Wolcott. The depth to water in them ranged from 3.6 feet in well No. 16a (see Pl. III) to 26.4 feet in well No. 75, and averaged 10.7 feet. Inquiries were made as to the reliability of 64 of these wells; 40 were said never to fail, but 24 fail in some seasons.

Stratified drift.—Stratified drift forms a flood plain in the valley of Mad River, in the southwestern part of Wolcott, and an esker-like hill in the northwest corner. In both areas it consists of porous, moderately coarse sand and gravel and therefore absorbs and discharges water more readily than the till. The depth to water in the five wells in stratified drift that were measured in Wolcott averaged 12.7 feet and ranged from 8.4 feet in well No. 73 to 18.9 feet in well No. 77. Wells Nos. 1 and 1a both fail because of their disadvantageous position on a steep slope.

RECORDS OF WELLS AND SPRINGS.

Dug wells ending in till in Wolcott.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1	....	Hilltop..	850	14.8	8.6	....	6 feet in rock; fails.[a]
2	....	Slope...	655	24.4	20.0	Windlass rig and deep-well pump.	
3	....	...do....	845	12.1	6.0	Windlass rig.........	Fails.
4	....	...do....	920	17.5	11.9	.....do..............	Unfailing.
5	....	...do....	860	18.4	13.3	.....do..............	Fails.
6	....	...do....	855	19.6	11.1	.....do..............	Rock bottom; fails.
7	....	...do....	830	14.0	8.1	Sweep rig...........	Fails.
7a	....	...do....	835	11.4	3.9	Chain pump and house pump.	Unfailing.[b]
8	....	...do....	730	13.4	7.8	Pitcher pump.......	
9	....	...do....	685	20.7	14.4	Windlass rig........	
10	....	...do....	860	30.3	21.0	Counterbalance rig and house pump..	Fails.
11	....	...do....	795	14.7	8.5	House pump........	Unfailing.

[a] 150 feet west of well No. 1. [b] 250 feet southwest of well No. 7.

Dug wells ending in till in Wolcott—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
12		Slope	760	16.0	10.3	Chain pump	Fails.
13		do	760	14.7	8.7	do	Unfailing.
14		Hilltop	755	20.1	15.1	Windlass rig	Fails.
15		Slope	825	18.2	9.4	do	Unfailing.
16		Swell	685	6.9	3.7	House pump	Fails.
16a		Slope	690	8.0	3.6		Do.[a]
17		do	620	13.9	10.2	Two-bucket rig	Do.
18		do	600	18.6	11.9	Pitcher pump and house pump.	Unfailing.
19	Mrs. Harriet Norton.	do	550	14.1	11.3	Windlass rig	Fails; for assay see p. 213.
20	H. W. Coe	do	600	24.1	14.6	Two house pumps	Unfailing.[b]
21		do	575	21.5	17.5		17 feet in rock.
22		do	535	19.	16.	Windlass rig	Fails.
23		Plain	545	26.0	19.4	Chain pump and gasoline engine.	Unfailing.
24		do	535	13.4	6.8	Chain pump	Fails.
25		do	515	12.3	6.4	do	
27		Slope	865	14.8	13.0		
28		do	900	14.1	8.2	Windlass rig	Unfailing.
29		Hilltop	950	26.7	13.7	do	Do.
30		Slope	910	14.0	9.8	Windlass and pulley rig.	Do.
31		do	850	13.1	5.2	Chain pump	
32		Hilltop	865	18.0	12.9	Two-bucket rig	Do.
33		Slope	825	20.0	15.5	Counterbalance rig	Fails.
34		do	800	21.3	12.2	Windlass rig	Do.
35		do	770	10.8	7.2	House pump	Unfailing.
36		do	790	14.8	12.8	Windlass rig	
37	August Burtin	Hilltop	840	14.0	9.2		Do.
38		do	845	19.0	10.3	Two-bucket rig	Do.
39		do	850	11.6	6.5	Windlass rig	Do.
40		do	850	18.4	12.6	Chain pump	5 feet in rock; fails.
42		Valley	620	33.1	13.1	Windlass rig	Unfailing.
43		Slope	555	12.5	9.4	do	Do.
44		Plateau	900	17.7	10.5	do	Fails.
45		do	905	11.5	5.9	do	Unfailing.
46		do	900	11.6	6.5	do	
47		do	925	18.7	10.7	(d)	Do.
48		do	935	9.9	7.2	Windlass rig	Do.
49		Slope	770	11.3	7.6	House pump	Do.
50		do	780	13.2	9.0	Windlass rig	Do.
51		do	780	12.0	8.7	do	Fails.
53		do	760	17.4	11.6	do	Do.
53a		do	720	15.5	7.8		Unfailing.[e]
54		do	700	14.9	11.9	Windlass rig[c]	Fails.
55		do	660	15.	9.	Chain pump	Unfailing.
56		do	705	17.5	8.1	(d)	
57		Plateau	900	16.6	10.1	Chain pump	Do.
58		do	885	16.2	11.0	do	6 feet in rock; unfailing.
58a		do	885	9.4	4.8	do	Unfailing.[f]
59		Slate	875	18.4	14.0	Pitcher pump	Do.
60		Plateau	885	12.3	5.6		Fails.
61	Bronson	Slate	840	13.1	9.1	House pump	Fails; rock bottom.
61a	do	do	840	12.8	7.0	(d)	Rock bottom; unfailing.[g]
62		do	810	17.8	10.0	Windlass rig	
63		do	820	17.3	10.3	Two-bucket rig	
64		do	780	18.1	13.9	do	
65		do	510	20.3	8.2	Chain pump	Unfailing.
66		do	520	12.6	8.4	do	Do.
68		do	505	22.1	21.0	(d)	
69		do	480	15.0	10.5	Windlass rig and house pump.	

[a] 100 feet north of well No. 16.
[b] This well was dug through blue clay and hardpan, which was so tough that it had to be picked. At the bottom a sandy layer was struck, and this yields an abundance of water.
[c] A buggy wheel used instead of a crank on the windlass.
[d] No rig.
[e] 300 feet southeast of well No. 53.
[f] 150 feet northeast of well No. 58.
[g] 200 feet southwest of well No. 61.

Dug wells ending in till in Wolcott—Continued.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
70	....	Slate....	480	16.5	12.0	Deep-well pump and house pump.	
71	....	...do....	490	20.6	15.0	Sweep rig and house pump.	Unfailing.
74	....	Slope...	540	27.4	18.0	Sweep rig..........	Fails.
75	....	Plain...	485	30.1	26.4	House pump........	
75a	....	...do....	475	12.1	8.0	Pitcher pump.......	Unfailing.[a]
76	....	Slope...	445	13.	....	....	Fails.
78	....	...do....	560	31.0	18.7	Deep-well pump....	Unfailing.
79	....	...do....	550	13.7	7.4	([b])..............	Do.
80	....	Plateau.	580	16.4	9.7	Chain pump........	Do.
82	....	Slope...	660	17.1	10.7	Two-bucket rig.....	Do.
83	....	Plateau.	600	15.6	6.1	Chain pump........	Do.
84	....	Slope...	645	19.4	9.6	.....do............	Do.
85	....	...do....	700	16.8	9.7	.....do............	Do.

[a] 100 feet southeast of well No. 75.

[b] No rig.

Dug wells ending in stratified drift in Wolcott.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to water.	Method of lift.	Remarks.
			Feet.	*Feet.*	*Feet.*		
1	....	Hilltop..	860	19.3	13.7	Windlass...........	6 feet in rock; fails.
73	....	Plain...	490	14.1	8.4	.....do............	Unfailing.
77	....	Slope...	455	23.9	18.9	Chain pump........	Do.

Drilled well in Wolcott.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Depth of well.	Depth to rock.	Diameter.	Yield per minute.	Water-bearing formation.	Remarks.
			Feet.	*Feet.*	*Feet.*	*Inches.*	*Gallons.*		
86	Carl Watson ...	Hilltop..	700	105	15	6	3	Schist...	For analysis see p. 213.

Springs in Wolcott.

No. on Pl. III.	Owner.	Topographic position.	Elevation above sea level.	Temperature.	Yield per minute.	Remarks.
			Feet.	*°F.*	*Gallons.*	
26	....	Swale.......	520	52	....	Fails.
41	Parsonage................	Slope.......	825	....	....	Piped to house; unfailing; for assay see p. 213.
52	....	...do.......	750	49	1	
67	....	By brook...	490	55	....	
81	....	...do.......	600	49	....	Unfailing.

QUALITY OF GROUND WATER.

The results of one analysis and two assays of samples of ground water collected in Wolcott are given below. The waters are low in mineral content and very soft. They are calcium-carbonate in chemical character except No. 86, which is of the sodium-carbonate type. All the waters have been classed as good for domestic purposes. Practically no scale-forming or foaming constituents are contained in the waters, and they are classified as good for use in boilers.

Chemical composition and classification of ground waters in Wolcott.

[Parts per million; collected Nov. 11, 191 ; analyst, S. C. Dinsmore. Numbers at heads of columns refer to corresponding numbers on Pl. III; see also records corresponding in number, pp. 211-212.]

	Analysis.[a]	Assays.[b]	
	86	19	41
Silica (SiO_2)	14		
Iron (Fe)	.04	0.20	Trace.
Calcium (Ca)	8.2		
Magnesium (Mg)	3.2		
Sodium and potassium (Na+K)[c]	11	Trace.	10
Carbonate radicle (CO_3)	.0	0	0
Bicarbonate radicle (HCO_3)	24	19	32
Sulphate radicle (SO_4)	6.9	Trace.	Trace.
Chloride radicle (Cl)	12	8	14
Nitrate radicle (NO_3)	16		
Total dissolved solids	84	[c] 44	[c] 65
Total hardness as $CaCO_3$	[c] 34	27	27
Scale-forming constituents [c]	44	40	40
Foaming constituents [c]	30	Trace.	30
Chemical character	Na-CO_3	Ca-CO_3	Ca-CO_3
Probability of corrosion [d]	(?)	(?)	(?)
Quality for boiler use	Good.	Good.	Good.
Quality for domestic use	Good.	Good.	Good.

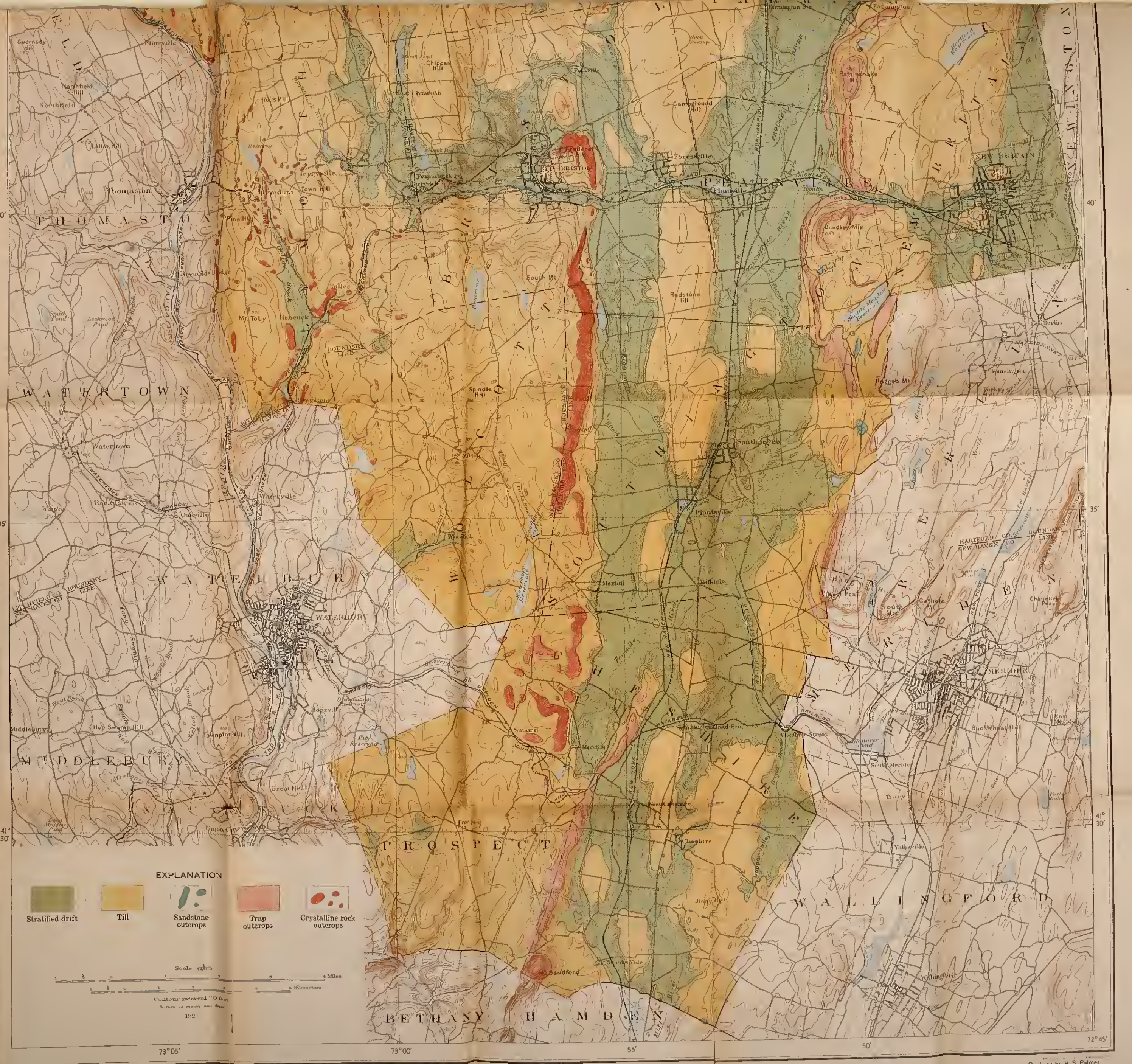
[a] For methods used in analyses and accuracy of results, see pp. 59–61.
[b] Approximations; for methods used and reliability of results, see pp. 59–61.
[c] Computed.
[d] Based on computed value; (?)=corrosion uncertain.

PUBLIC WATER SUPPLIES.

There are no waterworks serving any residents of Wolcott, but the town contains several reservoirs that belong to the systems of adjacent towns. In the southeast corner is a reservoir belonging to the Waterbury system. North of it on Falls Brook are two reservoirs of the Southington system, and still farther north New Britain has a reservoir on Roaring Brook.

INDEX.


COLEBROOK
HARTLAND
GRANBY
BARKHAMSTED
WINCHESTER
CANTON
NEW HARTFORD
TORRINGTON
BURLINGTON
HARWINTON
AVON
SIMSBURY
WEST HARTFORD
EAST GRANBY
BLOOMFIELD
MASSACHUSETTS
CONNECTICUT
BOUNDARY LINE
73°05'
73°00'
55'
50'
72°45'
42° 00'
45'
Torrington
Winsted
New Hartford
Collinsville
Riverton
Robertsville
Hartland
East Hartland
West Hartland
North Granby
Granby
West Granby
Canton Center
North Canton
Tariffville
Weatogue
Simsbury
Avon
West Avon
Unionville
Harwinton
Burlington
Pleasant Valley
Hampsted
Bushy Hills
Highland Lake
Colebrook
North Colebrook
Colebrook Station
Mill Brook
West Winsted
Winchester
Burr Reservoir
Burrville
Newfield
Drakeville
Torringford
Maple Hollow
Bakersville
Town Hill
Rattlesnake Hill
Huckleberry Hill
Round Hill
Johnnycake Mtn
Bushy Hill
West Hill Pond
NEW YORK NEW HAVEN AND HARTFORD RAILROAD
FARMINGTON RIVER

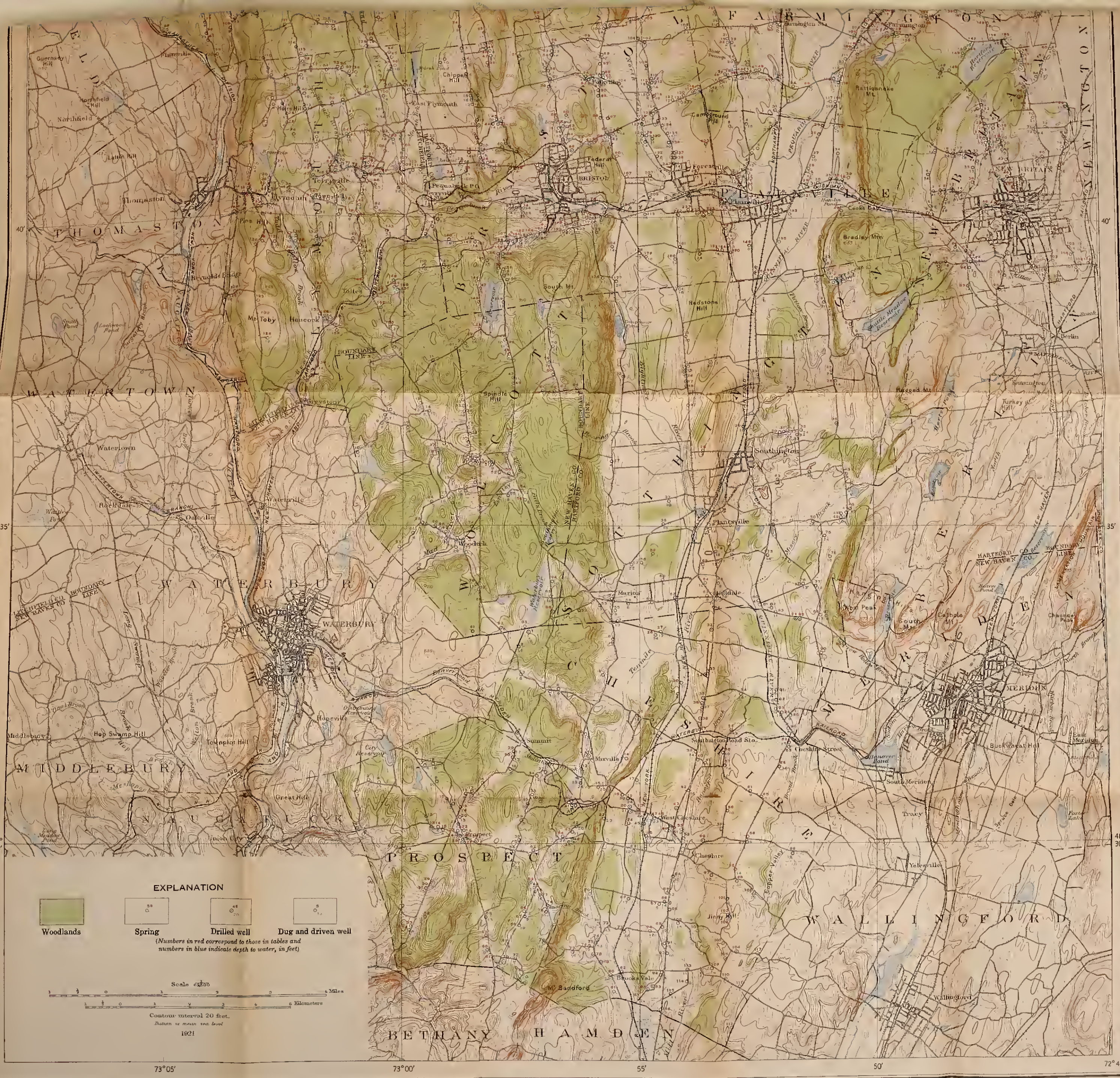


Base from U. S Geological Survey topographic maps

MAP OF SURFACE DEPOSITS OF THE SOUTHINGTON-GRANBY AREA, CONNECTICUT

Geology by H S Palmer


73°05'
73°00'
55'
50'
72°45'
42°00'
55'
50'
45'
COLEBROOK
HARTLAND
GRANBY
BARKHAMSTED
WINCHESTER
CANTON
NEW HARTFORD
TORRINGTON
AVON
BURLINGTON
HARWINTON
WEST HARTFORD
Winsted
New Hartford
Torrington
Unionville
Simsbury
Tariffville
Collinsville
Avon
Highland Lake
West Hill Pond
Burr Reservoir
Pleasant Valley
Canton Center
North Canton
Riverton
Robertsville
Colebrook
Hartland
East Hartland
West Hartland
Granby
North Granby
West Granby
Bushy Hills
Barndoor Hills
West Simsbury
West Avon
Burlington Station
Huckleberry Hill
Pond Ledge Hill
Round Hill
Nepaug
Bakersville
Burrville
Newfield
Daytonville
MASSACHUSETTS
CONNECTICUT
HARTFORD CO.
LITCHFIELD CO.
BERKSHIRE CO.
HAMPDEN CO.
CENTRAL NEW ENGLAND RAILWAY
NEW YORK NEW HAVEN AND HARTFORD RAILROAD
FARMINGTON RIVER



Base from U. S. Geological Survey topographic maps

TOPOGRAPHIC MAP OF THE SOUTHINGTON-GRANBY AREA, CONNECTICUT

Showing distribution of woodlands and location of wells and springs cited